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THE

DIVERSION OF THE WATERS

OF THE

GREAT LAKES

BY WAY OF

THE SANITARY AND SHIP CANAL

OF

CHICAGO

A BRIEF OF THE FACTS AND ISSUES

BY

LYMAN E. COOLEY

THE SANITARY DISTRICT OF CHICAGO

STATE OF ILLINOIS

FEBRUARY, 1913

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PREFACE.

On January 8, 1913, the Secretary of War formally refused the application of The Sanitary District of Chicago for a permit to increase the diversion of water to 10,000 cubic feet per second through the Chicago Sanitary and Ship Canal. The application was made on February 5, 1912, and was heard by the Secretary of War on February 28th and March 27th following.

While the Sanitary District has always taken the position that it had the right to divert or flow through its Canal sufficient of the waters of Lake Michigan to take care of the needs of the inhabitants of the District, yet, in view of the blending or close relations of State and Federal governments in such matters, the District has so far sought to obtain the acquiescence of the Secretary of War with respect to the amount of the flow of water.

In the recent hearings before the War Department the City of Chicago appeared and co-operated with the District. Statements were presented by the Sanitary District and by the City of Chicago in support of the application.

Immediately after the hearing it became apparent that the contentions and position of the Sanitary District should be set forth in some comprehensive form, and Mr. Lyman E. Cooley at once began the preparation of the material which is here presented. Mr. Cooley became consulting engineer of the Sanitary District December 16th last. Because of the early decision of the Secretary of War, it was impossible to present this new matter, together with a legal argument upon the questions involved, prepared by the District's Attorney.

In view of the recent agitation and the fact that there are few people who really understand the questions involved in this controversy, the Board of Trustees of The Sanitary District has caused this work to be published and placed in the hands of persons interested in the subject-matter, so that the history of the establishment of the outlet from Lake Michigan at Chicago and the construction of the Chicago Sanitary and Ship Canal—its present and future uses and purposes—may be better understood.

For the Board of Trustees of The Sanitary District of Chicago.

THOMAS A. SMYTH,
President.

Dated, CHICAGO, Illinois, February 15, 1913.

EXPLANATION.

The Sanitary and Ship Canal of Chicago (Drainage Canal) is thirty miles long between the Chicago River, six miles from Lake Michigan, and the Desplaines River above Joliet, and is made for a capacity of fourteen thousand second-feet. The immediate purpose of Chicago was sewage disposal by dilution, but the underlying motive of State Policy was a deep waterway, constructed in part by collateral utilities.

The canal (opened 1900) has carried about one-third its capacity, but sewage collection through adjuncts and increased population demands a much larger volume, and a flow of ten thousand second-feet is now desired, or two-thirds the joint capacity of the new and the old canal. Such diversion is objected to as working an irreparable injury to interests about the Great Lakes and along their outlets. These objections are belated and ill-advised.

Some relations to the deep waterway were taken up, at convenience, in December last. An appearance was entered at the hearings before the Secretary of War and the Chief of Engineers, U. S. A., February 28th and March 27th, and a general statement of issues was filed March 30th, all on behalf of the City of Chicago. The need of a comprehensive digest was apparent for many public reasons. Identification with the formative period of the Illinois enterprise, professional relations to every division of the route from the Gulf of Mexico to the Gulf of Saint Lawrence and the Hudson River and expert service in a number of issues respecting water-rights, have made possible this document in so short a time.

Chicago, December 9, 1912.

Lyman E. Cooley.

CONTENTS.

PART I.—PRELIMINARY STATEMENT.

A. THE SANITARY DISTRICT OF CHICAGO AND ITS OUTLET.

Topic Page
1 Description of the District.................................. 1
2 The Population 2
3 The Organic Law.................................. 4
4 The Works of the District.................................. 6
5 Expenditures 10
6 The Capacity of the Main Channel or Outlet.................. 11
7 The Determination of the Capacity.......................... 15
8 The Federal Permit 17
9 An Emergency under State Law.......................... 19
10 Illinois and Michigan Canal, sanitary use.................... 22

B. THE DEEP WATERWAY.

11 The Illinois Water Route.................................. 24
12 Waterway Provisions in the Sanitary District Act........... 25
13 Contemporary Waterway Legislation 28
14 Definition of State Policy.................................. 30
15 Waterway Amendment to State Constitution................. 32
16 Issues in the Courts.................................. 34
17 Recent Federal Examinations.............................. 35
18 Message of President Taft.................................. 37
19 Organized Promotion, Purpose of.......................... 38
20 The Population Concerned 40
21 The Solution of the Sanitary Problem...................... 41

C. THE GREAT LAKES.

22 Physical Geography, Elements of.......................... 45
23 Channel Improvements, History of......................... 50
24 The Davis Lock and Canal at Sault Ste. Marie............... 57
25 Permanent Changes in Lake Levels......................... 59
26 Fluctuations and Oscillations in Lake Level................ 66
27 Discussion of Official Data.............................. 71
28 Effect of Chicago Diversion, History of Discussion........... 78
29 Official Estimates of Effects of Chicago Diversion........... 83
30 Damages due to Chicago Diversion......................... 86
31 Remedies for Diversion.................................. 88
32 Urban Population 92
33 Federal Expenditures 93

PART II.—THE ARGUMENT.

D. THE ILLINOIS BIRTHRIGHT.

Topic Page
34 Early History of Illinois Route.............................. 97
35 Early Official Recognition 100
36 The Waterway State 104
37 The Illinois and Michigan Canal.............................. 107
38 Ship Canal Surveys 110
39 Evolution of the Sanitary District Law.............................. 113
40 Progress on the Chicago Drainage Canal.............................. 115
41 State of Missouri vs. State of Illinois, etc.............................. 117
42 No Adverse Action 121

E. NO MATERIAL EFFECT FROM CHICAGO DIVERSION.

43 Why Changes are not Material.............................. 124
44 Artificial and Natural Changes in Level.............................. 128
45 Lake Fluctuations and Oscillations.............................. 132

F. BENEFITS EXCEED DAMAGES.

46 The Amount of Damage.............................. 136
47 Relative Expenditures 137
48 Relative Population 139
49 Magnitude of Benefits 141
50 Nature of Redress 144

G. REMEDIES.

51 Nature of Remedies.............................. 145
52 Responsibility for Remedies 148

PART III.—FOREIGN RELATIONS AND CONCLUSIONS.

H. CANADA.

53 Physical Effects—Relative Importance of.............................. 149
54 Treaty Provisions 152
55 Boundary Waters Treaty—Interpretation of.............................. 156
56 The Rio Grande Precedent.............................. 160
57 Comity 163

I. RESUME.

58 The Essential Facts.............................. 165
59 The Argument 168
60 Canada 170

J. CONCLUSION.

61 Admonition 171

APPENDICES:

Page

1. Statement on Behalf of the City of Chicago 175
2. Ruling of the Secretary of War—Application of February 5, 1912 193

EXHIBITS:

Topic

1. Sanitary District of Chicago, Topography and Population .. 2
2. The Sanitary and Ship Canal, Map and Profile 4
3. Illinois Water Route; Profile, Chicago to St. Louis 11
4. Basin of the Great Lakes above Niagara, Map 22
5. Fluctuations of the Great Lakes, Hydrograph 26

The Diversion of the Waters of the Great Lakes by Way of the Sanitary and Ship Canal of Chicago.

PART I.

Preliminary Statement.

A. THE SANITARY DISTRICT OF CHICAGO AND ITS OUTLET.

1. *The Sanitary District of Chicago* is adjacent to the south end of Lake Michigan on the west, in the County of Cook, State of Illinois. It is the urban district of Chicago and its environs, with an area of 358.1 square miles. It covers the entire water front of Cook County, some thirty-three miles by the shore line, and naturally drained to the lake, for the most part, directly and by way of the Chicago River and the Calumet River.

The Original District was constituted by authority of the General Assembly under ''An Act to Create Sanitary Districts and Remove Obstructions in the Desplaines and Illinois Rivers,'' in force July 1, 1889. The original district was laid out with an area of 185 square miles and included a number of municipalities existent at the time of the passage of the law, but later annexed in large part to the City of Chicago. It was adopted by popular vote of 70,000 to 200, at the general election, November 5, 1889, and trustees were elected at the special election of December 12th. The Board organized January 12, 1890, and the Supreme Court affirmed the validity of the act on June 12, 1890.

The North Shore was annexed by the Act of 1903, thus extending the district to the northern county line. It comprised the Townships of Evanston, Niles, New Trier and parts of three others, an area of 78.6 miles along shore and in the Chicago basin, the drainage problem of which is identified with that of the original district.

The Calumet Region was also annexed by the Act of 1903, and covered the urban district south of Eighty-seventh street and west of the Indiana state line. It comprised that part of Chicago south of Eighty-seventh street, the Township of Calumet and parts of three other townships, an area of 94.5 square miles, wholly in the Calumet basin, the drainage problem of which is quite independent of that of the Chicago basin, but is complicated with that of the urban district east of the state line in Northern Indiana.

The Drainage Project, underlying the law, provides for an enlarged outlet across the Chicago Divide and by way of the Desplaines and Illinois Rivers. The original summit or portage was near Kedzie avenue, midway in a direct line between the Desplaines River and the Lake Shore, and was some nine feet above the mean lake level and was overflowed in times of flood in the Desplaines River. The Illinois route was a principal route for "trade and travel" from the time of the discovery in 1673.

2. *The Population of the Sanitary District* within the present limits, for the decennial years, 1850 to 1910, is tabulated below. The Calumet subdivision is given in a separate column, owing to its independent problem and different legal position, hereinafter referred to. The figures are original compilations from the Federal Census, except two numbers which were adopted after checking.

Year.	Sanitary District.	Calumet Sub-Division.	Per Cent in Calumet.
1910	2,311,810	134,370	5.81
1900	1,775,596	97,324	5.47
1890	1,150,082	49,966	4.34
1880	571,106	12,631	2.21
1870	324,758	*4,000	*1.23
1860	124,745	......	....
1850	35,568	......	....
1840	*5,330	*Approximate	

The State of Illinois, in 1910, had a population of 5,638,591, of which the Sanitary District contained forty-one per cent. (41%). The urban population of the state was 3,476,929, of which the Sanitary District contained 2,256,771, or sixty-five per cent. (65%).

The Illinois River Basin, in 1910, had a population of 1,595,743, which together with that of the Sanitary District of Chicago was sixty-nine per cent. (69%) of that of the state. The urban population of the Illinois River Basin was 367,331, which together with that of the Sanitary District was 2,624,102, or seventy-five and one-half per cent. (75½%) of that of the state. This population is directly and indirectly interested in the sanitary and waterway scheme.

The Contiguous Population along the water route and within ten miles thereof, between the Sanitary District and the Mississippi River, in 1910, was

445,828, which together with that of the district was 2,757,638, or forty-nine per cent (49%) of that of the state. The contiguous urban population was 208,679, which together with that of the district was 2,465,450, or seventy-one per cent. (71%) of that of the state. This entire population has an identical interest in the sanitary and waterway project.

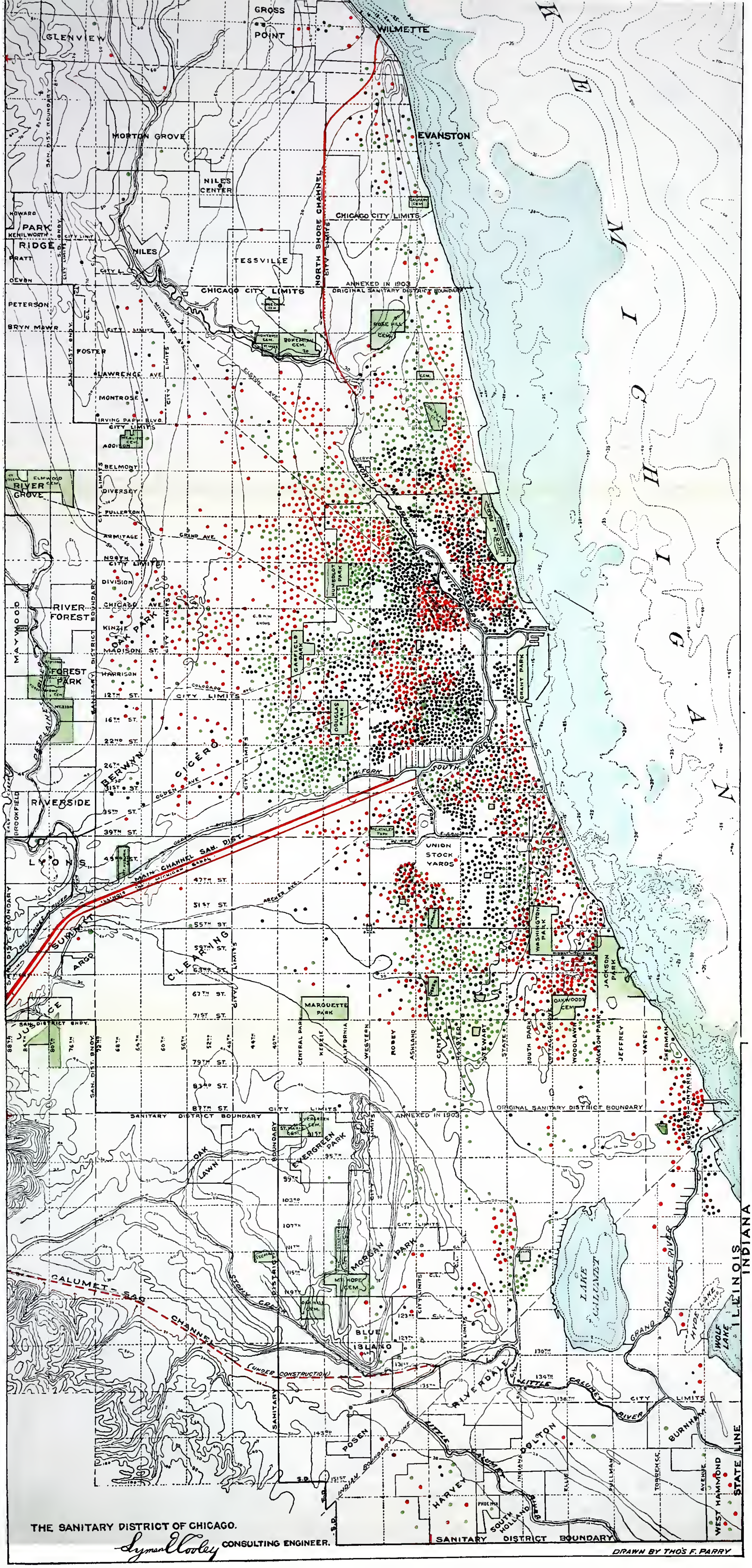
The Indiana Population in the Calumet Region, east of the state line, in 1900, was 21,033 on 47.5 square miles, mostly located at Hammond and Whiting, and within two and a half miles of the state line. The City of Gary has since been added, and the population in 1910 was 64,948.

The map attached hereto exhibits the distribution of the population within the Sanitary District of Chicago.

3. *The Organic Law* constitutes a quasi-municipal corporation, both by the intention of its framers and the decision of the Supreme Court. Its purpose was to provide a main channel or outlet and necessary adjuncts, in and by which "the drainage including the sewage" was to be disposed of by the several municipalities of the district (see Section 7 of the statute and legal opinion, July 26, 1895, page 2761 of Proceedings of Board of Trustees).

A sanitary condition is prescribed by Section 20:

> "Any channel or outlet * * * shall be of sufficient size and capacity to produce a continuous flow of water of at least 200 cubic feet per minute for each 1,000 of the population of the district drained thereby, and the same shall be kept and maintained of such size and in such condition that the water thereof shall be neither



THE SANITARY DISTRICT OF CHICAGO.

Lyman E Cooley CONSULTING ENGINEER.

DRAWN BY THOS F. PARRY

> offensive or injurious to the health of any of the people of this state;"

Section 23 states:

> "Such channel shall be made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cubic feet of water per minute for each 100,000 of the population of such district."

The channel "cut through a territory with a rocky stratum" is to have a capacity of not less than 600,000 cubic feet of water per minute, but in the clay is subject to progressive enlargement from an original capacity of 300,000 cubic feet of water per minute. The history of the ratio of dilution is set forth at length in Appendix B, page 29, "Report Upon the Chicago Drainage Canal by the International Waterways Commission, 1907."

The Dimensions of the channel, velocity of current and capacity, are everywhere expressed in minimums, the language used being "not less than."

Obstructions may be removed in the Desplaines and Illinois Rivers and the channel improved in order to avoid overflow and damage, and the removal of the navigation dams of the State of Illinois at Henry and Copperas Creek is directed.

Water Power Rights incidentally created between the end of the channel and "a river, or natural waterway or channel" are given to the district, and such rights were held by the Supreme Court June 12, 1890, to be a reasonable incident of other and necessary work.

The Amendments made to the law since 1889 relate largely to revenue, administration and definition. The Act of 1903 provides for the annexation of the North Shore and the Calumet Region, hereinbefore referred to. Section 25, of the original law, provided for the organization of auxiliary districts, but this proved unworkable and led to the Annexation Act of 1903, which also provides for a branch channel through the Sag Valley, but does not define its capacity. The same act provides for an extension of the channel for two miles for waterway and water-power purposes, and authorizes a special tax for this work.

4. *The Main Channel or Outlet* extends from the waters of the Chicago River at Robey street, six miles from Lake Michigan, to the Desplaines River at the controlling works at Lockport, a distance of 28.03 miles. It is located adjacent to the Illinois and Michigan Canal and generally parallel thereto, and after entering the Desplaines Valley at Summit the river is shifted to the opposite side so as to provide a location between the canal and river. Work was actually begun on September 3, 1892, and the channel was opened for the preliminary flow of water January 17, 1900, under a permit of the Governor, in accordance with Section 27 of the Act.

The Earth Section extends from Robey street to Willow Springs, 13.1 miles, with a bottom width of 202 feet, and surface width of 300 feet for a depth of 24 feet, and with a declivity of 1 in 40,000. *The Rock Section* extends from Willow Springs to the Controlling Works, 14.93 miles, with a bottom width of 160 feet and a surface width of 162 feet, between the rock and masonry sides, and with a declivity of

1 in 20,000. The grade of the bottom is 24.48 feet below datum at Robey street, 26.0 feet below at Willow Springs and 30.1 feet below at the controlling works. A width of 92 feet in the earth section for 7.8 miles between Robey street and Summit was not excavated, this being outside the territory with "a rocky stratum," and subject to progressive development under the law.

Collateral Work was required in the Desplaines River at Joliet before the channel could be opened. Collateral work was also required in the Chicago River, to prepare the same for the preliminary flow of water under the law.

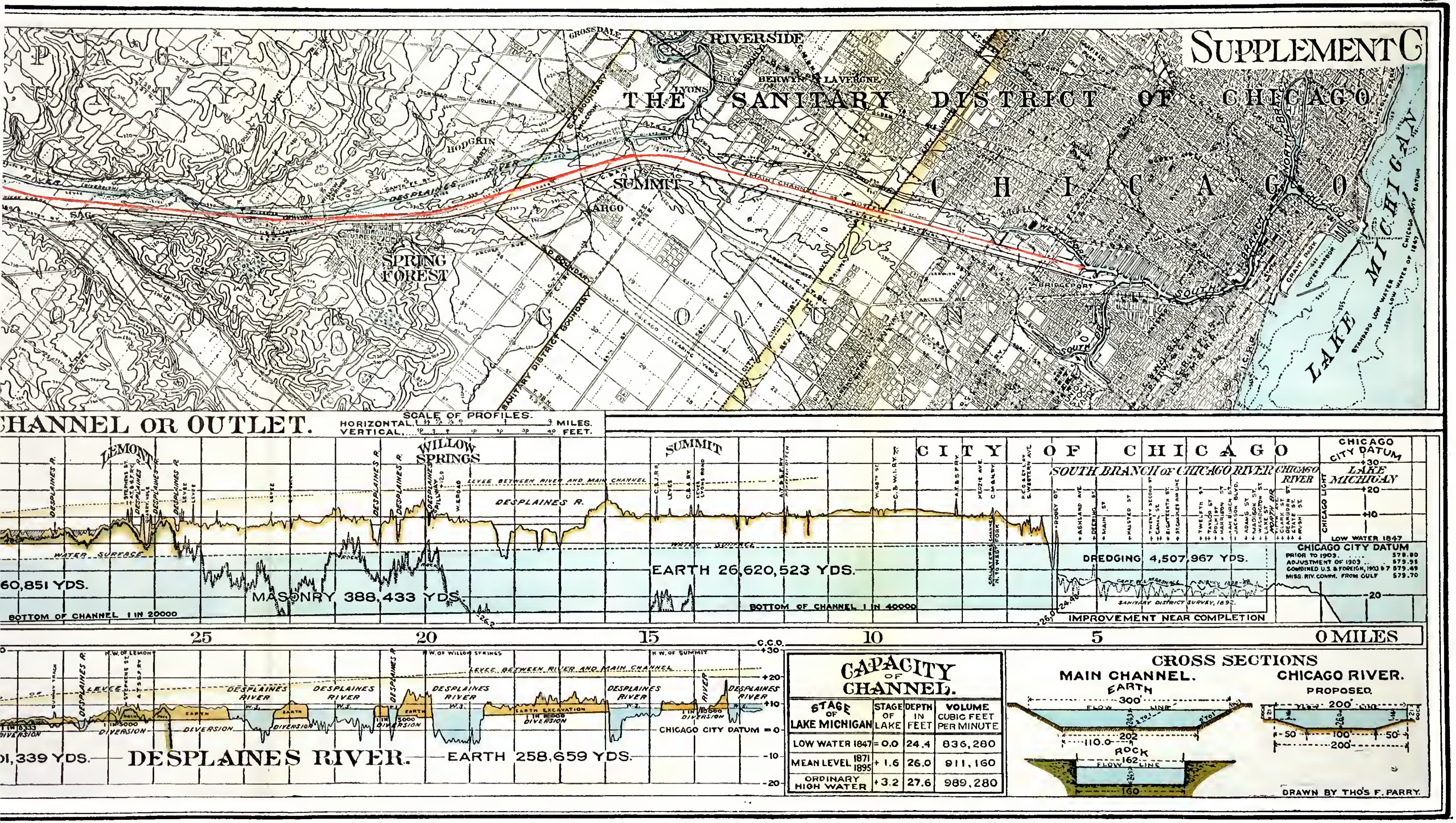
The Chicago River Improvement was definitely inaugurated in 1901, with a width of 200 feet and a central depth of 26 feet for a width of 100 feet on bottom, and center opening bridges. Special authority was granted by the General Assembly in 1901, but the Supreme Court affirmed the power of the District before the law went into effect. The improvement is not yet completed.

The Intercepting Sewer System and certain sewer diversions cover the lake front from Eighty-seventh street to the northern city limits, some twenty-one miles, and were constructed by the City of Chicago in conformity with the legal opinion of August 2, 1895, above referred to (see Topic 3), and the Report of the Pure Water Commission of 1897. The northern division discharges through the conduit, 16 feet in diameter, between the Lake and the North Branch on Lawrence avenue. This conduit was made larger than required for sewerage purposes in order to flush the North Branch, and is operated by the Sanitary District under agreement with the city. The conduit was operated in connection with the intercepting sewers from February 1, 1908, and for flushing purposes intermittently in 1908 and 1909, and regularly from May 28, 1909. The southern division discharges through the Thirty-ninth street conduit between the Lake and the South Fork, and is made 20 feet in diameter in order to flush the South Fork and add to the water supply in the Main Channel, and is also operated by the Sanitary District under agreement with the city. This conduit was operated in connection with the intercepting sewers by a provisional plant from October 1, 1904, and permanently from December 28, 1905, and for flushing and water supply purposes intermittently from July 1, 1907, and regularly from May 1, 1908.

The North Shore Canal extends from the North Branch at Lawrence avenue northerly to the Lake Shore in the Village of Wilmette, and is intended to provide an outlet for the shore towns and the territory north of the city limits, and to furnish additional water for flushing the North Branch. This channel is 26 feet wide on bottom and 12 feet deep, and is operated by pumping works at Wilmette, and was opened November 29, 1910, but the north shore towns have not yet availed themselves of this outlet except to a limited extent in the Village of Wilmette and the City of Evanston. The flow from this channel comes by way of the North Branch to the junction of the Chicago River and is not an additional contribution of water to the Main Channel.

SUPPLEMENT C

THE SANITARY DISTRICT OF CHICAGO



CAPACITY OF CHANNEL.

STAGE OF LAKE MICHIGAN	STAGE OF LAKE	DEPTH IN FEET	VOLUME CUBIC FEET PER MINUTE
LOW WATER 1847	= 0.0	24.4	836,280
MEAN LEVEL 1871 1895	+ 1.6	26.0	911,160
ORDINARY HIGH WATER	+ 3.2	27.6	989,280

The Calumet-Sag Branch has made little progress, owing to the issue in the United States Court and other complications. A project has been adopted for a channel with a capacity of 120,000 cubic feet of water per minute, right of way is being procured and four contract sections (4.86 miles) have been let.

The Extension of the Main Channel at Lockport was made under the Act of 1903, for a distance of two miles from the controlling works to the present water power station, and put in operation December 28, 1907.

The Spillway above Summit formerly divided the floods in excess of a certain volume, the same coming in part by way of the Ogden-Wentworth ditch to the Chicago River. The old spillway was closed and a new one opened to the Main Channel below Willow Springs in March, 1909, and floods from the Desplaines River contributed to the flow in the Main Channel in April and May of that year and since.

The plate attached hereto exhibits the location and principal features of the Main Channel or Outlet and is Supplement C, Lakes-to-the-Gulf Deep Waterway series.

5. *The Net Revenues of the Sanitary District* from its organization to January 1, 1912, have been:

Taxes collected	$48,654,404.42
Bonds outstanding	20,149,000.00
Miscellaneous receipts	815,431.74
Total	$69,618,836.16

The Net Expenditures for the same period have been:

Main Channel and river diversion, construction, controlling works, bridges and right of way	$26,599,866.52
Chicago River improvement—bridges and right of way	10,919,612.58
North shore canal and North Branch constn., pumping works, bridges and right of way	3,204,741.21
Calumet-Sag project, constn., bridges and right of way	705,882.69
Joliet improvement	1,603,035.14
Main Channel extension and water power	4,517,925.14
Thirty-ninth street pumping station, Western avenue sewers	714,881.65
Maintenance, operation and damages	1,180,440.66
Administration and general expenses	6,955,089.95
Interest and taxes	12,123,015.62
Total	$68,524,491.16

The Net Expenditures by the City of Chicago on the intercepting sewer system along the Lake Front have been	$ 6,706,804.37
The Total Expenditures by the Sanitary District and by the city have been	$75,231,295.53

The same ratio extended over the continental United States represents over three billion dollars.

No Estimate has been made of the Sanitary District and municipal expenditure required to complete the program, but the total will be increased to one hundred million dollars or more.

The Sanitary Program contemplates parks and parkways along the water front, now largely acquired by the Park Boards, and large expenditures have been made and are yet to be made.

The Waterway and Harbor Development must conform to the sanitary program, and this will involve a large expenditure in the near future.

6. *The Capacity of the Main Channel or Outlet* was determined from observations made for the Expert Commission of 1901. (See Proceedings, Board of Trustees, June 19, 1901, pages 7248-50; see also Report of the Internal Improvement Commission of Illinois, 1907, page 15; also Report upon the Chicago Drainage Canal by the International Waterways Commission 1907, Appendix B, page 33.) These estimates presume a radical improvement of the Chicago River between the Lake and Robey street and the development of the Main Channel in the clay between Robey street and Summit, 7.8 miles, for a bottom width of 220 feet, all as set forth by the Expert Commission, above referred to.

Lake Michigan.	Stage.	Depth of Channel in Feet.	Volume in Cubic Feet per Minute.
Low water of 1847.....	0.0	24.4	836,280
Mean level 1871-1895...	1.6	26.0	911.160
Ordinary high water...	3.2	27.6	989.280

The low water of 1847 corresponds to the mean of eight months, April to November, of that year, and is 4.74 feet below the high water of 1838, all as determined at Milwaukee. (See Report U. S. Deep Waterways Commission, 1896, page 99.) It is the same as Illinois and Michigan Canal datum, Chicago datum and Sanitary District datum. In a cycle of years the lake has ranged above the limits given (3.2 feet) for about the same time as it has ranged below datum. The capacity of the channel based on the preliminary determination above cited has usually been given as 840,000 cubic feet of water per minute in round numbers, or 14,000 cubic feet per second.

The Capacity of the Preliminary Channel in the clay for 7.8 miles, between Robey street and Summit, with its normal declivity, is estimated at sixty per cent. (60%) of that of the full channel below, or 500,000 cubic feet per minute. In view of the larger capacity below, however, the declivity can be accentuated so as to pass 600,000 cubic feet per minute, pending its enlargement.

The Capacity of the Chicago River upon the official plan of improvement, now nearing completion, was estimated by the Chief Engineer of the Sanitary District at 480,000 cubic feet of water per minute, to which was to be added 120,000 cubic feet of water per minute by way of the Thirty-ninth street conduit and the South Fork, a total of 600,000 cubic feet of water per minute, or 10,000 cubic feet per second. (See Proceedings, Board of Trustees, June 19, 1901, page 7232.) The Expert Commission of 1901 estimated the capacity by the official plan, so modified as to give the full section at bridge openings at 390,000 cubic feet per minute, and the continuous working capacity of the Thirty-ninth street conduit at 70,000 cubic feet per minute, a total of 460,000 cubic feet per minute (page 7285, foregoing reference). The actual capacity of the combination of river and conduit can only be determined by experience, as was the case with the river improvement preliminary to the opening of the Main Channel, referred to in topic 8.

The Flow Through the Main Channel is determined from records kept at the Controlling Works and the Power Station at Lockport. The flow for the first five years was published in the Report of the Internal Improvement Commission of Illinois, 1907, page 22. The following tabulation is compiled from the record on file in the case of the People of the State of Illinois *versus* the Economy Light and Power Company, 1908, and covers the years 1900-7. The four later years are furnished directly by the Sanitary District.

MEAN YEARLY FLOW.

Year.	No. of Weeks.	Cubic Feet Per Minute.
1900	49	188,136
1901	52	242,323
1902	52	257,006
1903	53	299,299
1904	52	272,723
1905	52	268,703
1906	52	241,636
1907	52	306,818
1908	..	319,000
1909	..	340,000
1910	..	358,000
1911	..	375,000

The apparent volume at Lockport has been increased from a number of causes:

(*a*) During the prevalence of the floods which were liable to back out into the lake the flow has been temporarily increased.

(*b*) The restriction on flow has not been rigidly adhered to during the closed season of navigation. In this connection see Permit for winter of 1903. (See Topic 8.)

(*c*) Floods in the Desplaines River have contributed to the flow in the Main Channel since March, 1909, by way of the Spillway at Willow Springs.

(*d*) The Thirty-ninth street conduit has been operated intermittently after July 1, 1907, and regularly from May 1, 1908 (see Topic 4), and has furnished an extra supply by way of the South Fork, which traverses the river for 0.6 miles above the entrance of the canal at Robey street, where the river has the improved capacity.

(*e*) The net amount which has normally passed through the unimproved stretch of the river, between the Lake and the South Fork, can be determined by eliminating the foregoing elements.

7. *The Additional Capacity* of the Main Channel, or the excess above 10,000 cubic feet per second, has been gratuitously assumed in later official statements and reports to have been unlawful and an abuse, and due to incapacity in the original determination, and such views have filtered into United States and even International Reports. A tacit admission prevails in some quarters that the extra capacity is not to be availed of, or is to be appropriated to outlying regions, thus abandoning a part of the capacity provided at large cost for the Chicago River district. Such views are due to unfamiliarity with the organic law and the considerations which determined that law and its interpretation, and the period when the Main Channel was constructed.

The Organic Law everywhere states ratios of dilution and capacity of channels by minimums, the language in each case being "not less than." The actual dilution and capacity above these minimum limits is left to the judgment of the Board of Trustees of the Sanitary District. The early boards and their responsible engineers held the view that the capacity should be safely above the legal limit, but did not admit the contention of the undersigned that such capacity should be 1,000,000 feet per minute in order to insure the legal volume (600,000 cubic feet per minute) under ice cover.

The Original Computations for dimensions and capacity were made by the undersigned, assisted by W. A. Lydon, when chief assistant for the Drainage and Water Supply Commission in 1886-7, and the investigation was continued under his direction as Chief Engineer of the Sanitary District by Principal Assistant Engineer Thos. T. Johnston, assisted by J. H. Spengler. The Board of Trustees called for the results respecting channels of a capacity of 1,000,000, of 600,000 and of 300,000 feet per minute, respectively, on June 1, 1892 (see Order, page 536, of Proceedings), and the Chief Engineer reported December 28, 1892, and submitted elaborate tables covering the subject-matter of the investigation, and the same was ordered printed in a separate pamphlet. (See Proceedings, pages 966-9.) The most conservative co-efficients were used in order to save any question under Section 27 requiring state inspection before the Channel was opened. In constructing the channel it was found practicable to use the channeling machine in the rock, thus giving regular and smooth sides to the channel. This led the then Chief Engineer, Mr. Benezette Williams, to suggest in his Annual Report, January 25, 1893 (Proceedings, page 1009), that the channel would carry more than the required volume, and in a special report March 1, 1893 (Proceedings, page 1066), he recommends that the grade in the rock cut between Willow Springs and Lockport be reduced by two feet by raising the same at Lockport. The matter was taken under advisement and is referred to in Proceedings of June 1st and August 2, 1893 (pages 1293 and 1360), and is finally disposed of on September 6, 1893 (Proceedings, page 1439). The original grade at Lockport was retained, and the declivity above so reduced as to give a depth of 22 feet in place of 20 feet, the water surface for such depth at the junction of the Main Channel with the Chicago River at Robey street being 2.48 feet below the legal datum plane. It was practically certain, and was so understood, that the capacity would exceed the minimum requirement by some twenty per cent. (20%), or reach 720,000 cubic feet per minute. The radical improvement of the Chicago River, or some equivalent feeder, as outlined by the Expert Commission of 1901, adds 2.4 feet to this depth and gives a capacity of 840,000 feet in round numbers as set forth in the preceding topic. Such volume is a preliminary determination by the Expert Commission, and no other or final determination has been made. The history of the matter is referred to at some length in Report upon Chicago Drainage Canal by the International Waterway Commission, 1907 (Appendix B, page 29, *et seq.*), and in a paper on the Sanitary and Ship Canal of Chicago—solution of the sanitary problem, tenth and eleventh meetings of the National Conference of State Boards of Health, 1894-1896, page 166 *et seq.*

8. *The Federal Permit* of May 8, 1899, as recited therein, is granted pursuant to Section 10, Act of Congress, March 3, 1899, and on application of the Sanitary District, but such application is not found in the Official Proceedings of the Board of Trustees. The Proceedings for May 10, 1899, page 5675, note that the President of the Board presented the Permit, and it was ordered printed and placed on file. The Permit refers to an improvement of the Chicago River between the Lake and the Drainage Canal at Robey street for "a flowage capacity of 300,000 cubic feet per minute with a velocity of 1¼ miles an hour." The United States assumed jurisdiction of the Chicago River by the Act of June 3, 1896, and on July 3d the Sanitary District was authorized to make the improvement above referred to. In substance, the Permit was for the passage of 300,000 cubic feet of water per minute through the Chicago River, or so much thereof as the river could carry without undue injury to navigation, and was subject to modification, revocation and the will of Congress. The capacity of the river improvement had been over-estimated, and after experimenting with various volumes the Supplemental Permit of December 5, 1901, fixed the amount at 250,000 cubic feet of water per minute through the river, and no change has since been made therein other than a permit for a temporary flow of 350,000 feet per minute during the winter of 1903. The history of the Permit is set forth in the Report upon the Chicago Drainage Canal by the International Waterways Commission, 1907, Appendix D, page 36.

This Permit, on its face, relates solely to the passage of water through the Chicago River between the Lake and the Drainage Canal at Robey street, and is conditioned only by the capacity of said river and the protection of navigation therein. It does not necessarily apply to flow in the closed season and to waters received through adjuncts. (See Topic 42.)

9. *An Emergency in the Operation of the Main Channel or Outlet* has arisen by reason of the deficiency therein of the flow of water required by the State law. The President of the Sanitary District, under date of July 15, 1901, requests the Secretary of War to raise the then limit of flow of 200,000 cubic feet of water per minute, and states "that the water in the main drainage channel has become greatly polluted and very offensive both to sight and smell and is working such hardship upon the valley communities as to evoke frequent protests from various cities and municipalities along the Desplaines and Illinois valleys." (See page 37, Report upon the Chicago Drainage Canal by the International Waterways Commission, 1907.) The Report of the Chief Engineer of the Sanitary District, under date of October 12, 1911 (pages 1226-1301, of the Proceedings of the Board), states that during the prolonged hot season, just passed, the water in the Main Channel or Outlet was not only unwholesome and unsatisfactory but that such conditions extended to the Desplaines and Illinois Rivers as far as Marseilles, and that deposits of 2,338,334 cubic yards have occurred in the Main Channel since it was opened, in 1900. It is reported from other sources that fish life further down the Illinois River has been seriously prejudiced.

The Population in the Sanitary District in the summer of 1911 is estimated at 2,370,000, and the minimum flow in the Main Channel should have been not less than 474,000 cubic feet per minute, or 7,900 cubic feet per second. The flow under "Permit" through the Chicago River has not been increased above 250,000 since 1901 and 1903, when bad conditions were reported on a permitted flow of 200,000 feet per minute with an estimated population of 1,830,000 within the present limits of the District. Meantime the sewage in the Main Channel has increased from the following causes:

(*a*) The population has increased by 540,000, about thirty per cent. (30%), and a larger proportion of the population is now tributary.

(*b*) The sewage of the shore population between Thirty-first and Eighty-seventh streets was intercepted and turned through the Thirty-ninth street conduit in 1904 and 1905, and the South Fork has been flushed intermittently from July 1, 1907, and regularly since May 1, 1908. The South Fork was in effect a septic tank, receiving enormous trade wastes and the sewage of a large population, and the addition of the shore population together with the active circulation of this Fork has greatly increased the burden in the Main Channel. (See Topic 4.)

(*c*) The North Side intercepting sewer system delivered the sewage of the shore population through the Lawrence avenue conduit to the North Branch from February 1, 1908, and the North Branch was flushed intermittently in 1908-9, and regularly since May 28, 1909. The circulation in the North Branch was made more active through the opening of the North Shore Canal November 29, 1910. A feeble circulation existed in the lower North Branch through the operation of the Fullerton avenue conduit, but it had a very large population and large trade wastes, and the addition of the shore population and the more active circulation by means of the Lawrence avenue conduit and the North Shore Canal has also materially increased the burden in the Main Channel. (See Topic 4.)

The more active circulation in the South Fork and North Branch has brought to the Channel the bulk of the trade wastes which were before largely disposed of through septic action and sedimentation, and this is also true of the large tributary population, and there has been the addition of the shore population by means of the intercepting sewers. These facts, together with the growth in the population, sufficiently account for the condition in the Main Channel in the summer of 1911, and this condition was accentuated by the further fact that the prolonged heated season raised the temperature of the lake water above normal, thereby reducing the oxygen content.

The fact that the flow in the Channel since it was opened has been so small in proportion to its capacity, some thirty per cent. (30%) and upwards, has led to deposits of "sludge," particularly in the broader reaches between Summit and Willow Springs, and between the Controlling Works and Power Station at Lockport, but deposits in the rock cut where the velocity is higher have been limited. The so-called sludge deposits are recognized as largely composed of fine silts coming in part from shore wash, rather than organic matter, and would not occur with a normal current in the Channel, such as would be produced by a flow in proper relation to the population.

10. *The Illinois and Michigan Canal,* across the Chicago Divide, was used for sewage disposal within its first decade and as soon as Chicago had attained sufficient growth to have a sanitary problem. The Canal was opened in 1848 on a modified plan with the summit level eight feet above datum, and fed from the Desplaines and Calumet rivers and from the Chicago River by a lift-wheel at Bridgeport, and this wheel was operated to cleanse the Chicago River.

"*The Completion* of the Illinois and Michigan Canal, upon the plan adopted by the State in 1836, upon the original deep cut plan," was authorized by the General Assembly February 16, 1865, in order to, among other things, "most effectively secure the thorough cleansing or purification of the Chicago River" by gravity flow. The City of Chicago executed the work in 1866-71. "An Act to relieve the lien of the City of Chicago upon the Illinois and Michigan Canal and revenues by refunding to said city the amount expended by it," etc., approved October 20, 1871, was passed by the General Assembly in extraordinary session immediately after the great fire, and "the sum of two million, nine hundred and fifty-five thousand three hundred and forty dollars" ($2,955,340) was repaid to the city.

The Canal Deepening was insufficient for the growing needs of the city, and the resulting sanitary condition in the canal and valley was graphically set forth in the joint resolution of the General Assembly in 1881, which provided that "if said city shall proceed without delay to cause a flow into the canal from the Chicago River sufficient to dilute and purify the waters and thus remedy the evils complained of, said flow to be not less than 60,000 cubic feet per minute * * * or so much thereof as in their judgment said canal can carry,'' Chicago could continue the use of the canal for sewage disposal.

The Improvement of the Illinois and Michigan Canal is reported upon by Major W. H. H. Benyaurd in the Report of the Chief of Engineers, U. S. A., Volume II, page 1761, for 1883. Referring to lockage, the Report says: ''The water will be supplied by pumps now in course of construction at Bridgeport which furnish 1,000 cubic feet per second.'' The pumping works referred to were erected by the city and had a tested capacity of 60,000 cubic feet per minute under a head of eight feet (tested and accepted in 1886). They were actually operated by the city until after the Main Channel was opened, in January, 1900, for such volume as the Canal Commissioners directed or required, usually ranging from 60 to 80 per cent. of the limit stated in the joint resolution.

The Capacity of the canal at various elevations was determined by actual observation, the stage for 60,000 cubic feet per minute being 5.7 above datum at Bridgeport, and such elevation was used by the Expert Commission of 1901. (See Proceedings, Board of Trustees of the Sanitary District, June 19, 1901, pages 7266-7.) The capacity at the original elevation of the summit level, or eight feet above datum, would be more than fifty per cent. (50%) additional. The feasibility of operating the canal for a capacity of 90,000 feet per minute was determined in 1888-9, but such program was not adopted.

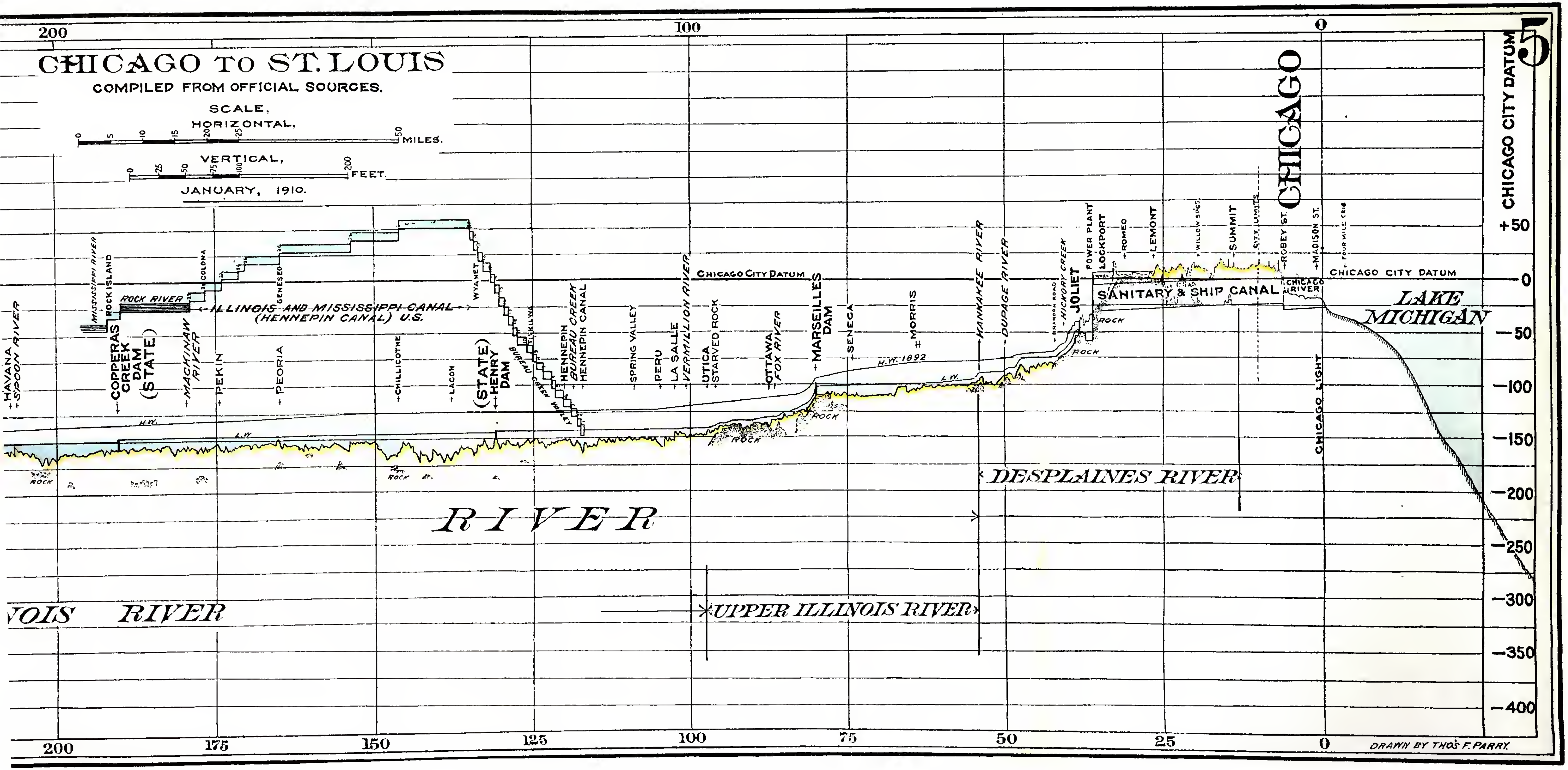
The Pumping Works cost the City of Chicago, for construction, maintenance and operation, the sum of $1,439,769.53, up to July 14, 1900, when the works were transferred to the Sanitary District.

The International Waterways Commission refers briefly to the use of the canal for sewage disposal in the opening paragraphs of its Report on the Chicago Drainage Canal, 1907 (see Topic 39).

B. THE DEEP WATERWAY.

11. *The Illinois Outlet* of the Upper Lakes persisted under existing surface and climatic conditions and a remnant of the ancient stream bed still survives in Lake Peoria and the non-conformable regimen of the present Lower Illinois River. The site of Chicago in large part is the floor of the old bay bounded by the beach lines of the higher lake level. Through this floor from the present Village of Lyons coursed the Desplaines River and its channel, in large part, survived and was maintained by overflow waters, as Mud Lake and the South Branch of the Chicago River with its ramifications.

The building up of the divide at Kedzie avenue, already referred to in Topic 1, diverted the ordinary flow of the Desplaines River along the ancient outlet, but so recent was the change that remnants of the former stream bed survived in the pools and expanses between Lyons and Lemont, in the bare rock floor from Lemont to below Joliet and in Lakes Joliet and Dupage, much depreciated since inhabitation.



CHICAGO TO ST. LOUIS

COMPILED FROM OFFICIAL SOURCES.

SCALE,
HORIZONTAL,
VERTICAL,

JANUARY, 1910.

The Real Divide was the rock floor above Lemont, five feet above mean lake level and reaching lake level near Romeo, twenty-eight (28) miles from the lake shore; but the drop is some seventy-six (76) feet in the next eleven (11) miles to Lake Joliet, and this entire distance is usually designated as "The Chicago Divide." The rock-bound valley continues in pools and intermediate rapids for fifty-five (55) miles to Utica bridge, where the original low water level was one hundred and forty-seven (147) feet below the low water of Lake Michigan (1847). The alluvial valley extends thence two hundred and thirty (230) miles to the Mississippi River at Grafton, with a low water declivity of only twenty-eight (28) feet, an inheritance from the ancient outlet.

This Remarkable Water Trail determined Indian movement, guided exploration and was utilized in the fur trade. Long prior to settlement an improved water route was projected and crystallized the policy of the new state, and its development determined the site of Chicago and ministered to its early growth.

The larger waterway and sanitary purpose is another stage in the evolution of obvious physical conditions.

The profile hereto attached exhibits elevations and distances along the Illinois Water Trail, and is part of Exhibit 5, Lakes-to-the-Gulf Deep Waterway.

12. *The Waterway Policy* of the State of Illinois breathes through the Sanitary District Act of 1889:

(*a*) Section 7 authorizes the District "to make and establish docks adjacent to any navigable channel made under the provisions hereof for drainage purposes, and to lease, manage and control such docks.''

(*b*) Section 12, as amended in 1897, provides for the construction of movable bridges across the Main Channel or Outlet, and Section 21 provides redress by direct action in the Supreme Court of the State.

(*c*) Section 23 fixes the minimum dimensions of channel and maximum velocity of current therein in the interest of navigation, and such specification would be otherwise uncalled for.

(*d*) Section 23 further provides that ''if at any time the general governmment shall improve the Desplaines or Illinois Rivers so that the same shall be capable of receiving a flow of 600,000 cubic feet of water per minute, or more, from said channel * * * then such Sanitary District shall within one year thereafter enlarge the entire channel leading into said Desplaines or Illinois Rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet of water per minute.'' This provision covers the entire Main Channel or Outlet from it's connection with the Chicago River at Robey street, in the opinion of the General Counsel, John P. Wilson, who drew the Sanitary District Act, and the attorney, Hon. Orrin N. Carter, now Chief Justice of the Supreme Court of Illinois. (Proceedings of the Board of Trustees, October 24, 1892, pages 826 *et seq.*, paragraphs Nos. 3 to 5.)

(*e*) Section 24 provides that ''when such channel shall be completed, and the water turned therein, to the amount of 300,000 cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the general government shall improve the Desplaines and Illinois Rivers for navigation, to connect with this channel, said general government shall have full control over the same for navigation purposes.'' It appears that the United States is to have control when a through water route is provided, and that the Main Channel or Outlet from the Chicago River [(*d*) above] is to be completed to its full capacity within one year after the United States shall so improve the Desplaines and Illinois Rivers as to care for a volume of 600,000 cubic feet of water per minute, or more.

(*f*) *The Act of 1903* provided for the extension of the Main Channel to the Upper Basin at Joliet, and provided for a lock by which boats could pass down to Dam No. 1 at Joliet, so that the Main Channel could be operated in connection with the Illinois and Michigan Canal below said Dam No. 1. (See Section 2 of Act.) Said extension continued the summit level with its full dimensions for a distance of two miles, and provided a channel of a depth of 20 feet and a river improvement of 10 feet, thence to Dam No. 1, 2.65 miles, and the extension was opened December 28, 1907. Section 3 provides for the free navigation of the Channels of the Sanitary District and extends thereto ''The rules of the United States government now in force, regulating navigation on the Chicago River.''

The lock was opened July 13, 1910, pursuant to ''an Act to provide a Navigable Connection between the Desplaines River and Upper Basin of the Illinois and Michigan Canal at Joliet and the Sanitary

District Channel, and to compel the removal of obstructions in and over said River in aid of the construction of a Deep Waterway between Lockport and Utica'' (approved and in force March 4, 1910).

13. *A Contemporary ''Act* in Reference to the Improvement of the Illinois and Desplaines Rivers,'' etc. (in force July 1, 1889), repealed the act of 1887 which ceded to the United States the locks and dams at Henry and Copperas Creek, on condition that it produce a through waterway of a depth of seven feet from the Mississippi River to Lake Michigan. Section 2 cedes these State Works to the United States ''on condition that the dams shall be removed whenever the depth now available for navigation can be secured and maintained by channel improvement without the aid of said dams: Provided, that said depth shall be assured upon the removal of said dams, or that such removal shall not materially impair navigation.'' Section 4 ''bases this act of cession upon the condition that the plan of improving the Illinois River below La Salle by slack-water, maintained by dams and locks, be changed to a plan of improvement by means of an open channel in conjunction with a water supply from Lake Michigan.'' Section 3 provides that in case the United States does not accept this cession within four years, ''the Canal Commissioners of the State of Illinois are authorized and instructed to remove the dams at Henry and Copperas Creek.''

The Sanitary District Act, Section 23, also provides that ''The district constructing a channel to carry water from Lake Michigan of any amount authorized by this act, may correct, modify and remove obstructions in the Desplaines and Illinois

Rivers wherever it shall be necessary so to do to prevent overflow or damage along said river, and shall remove the dams at Henry and Copperas Creek in the Illinois River, before any water shall be turned into the said channel. And the Canal Commissioners, if they shall find at any time that an additional supply of water has been added to either of said rivers, by any drainage district or districts, to maintain a depth of not less than six feet from any dam owned by the state, to and into the first lock of the Illinois and Michigan Canal at La Salle without the aid of any such dam, at low water, then it shall be the duty of said Canal Commissioners to cause such dam or dams to be removed.''

The Volume of Water from Lake Michigan required to produce a navigable low water depth of six feet in the natural river is stated at 4,555 cubic feet per second in a report by Gen. James H. Wilson, U. S. A., 1866-8. The effect of different volumes of water is treated in testimony of April 7, 1887, before a joint committee of the General Assembly, and also in the Lakes and Gulf Waterway as related to the Chicago Sanitary Problem, 1890-1, both by the undersigned. The Sanitary District Act and contemporary legislation was framed in 1888 by a joint committee of the General Assembly with the Mayor of Chicago as Chairman, and a flow of 5,000 cubic feet of water per second from Lake Michigan was deemed sufficient to justify the removal of the dams, as they were so advised by their consulting engineer, the undersigned.

The Henry Dam and Lock was authorized by the acts of February 28, 1867, and February 25, 1869, and was available for navigation in 1871. The Copperas Creek Dam and Lock was authorized by the act of April 17, 1873, and was available for navigation in 1877. The Sanitary District sought to remove these dams in 1899, but was enjoined by the Canal Commissioners. The demurrer of the Sanitary District was overruled by the Supreme Court February 19, 1900, and the case remanded for trial on its merits, but the suit has not been terminated. The court construed the act to be permissive and held that the dams should not be removed until an equivalent navigable depth should be available It has been stated that the experts for the Canal Commissioners determined that a flow of 7,000 cubic feet per second would be required to produce such equivalent depth unless the stream be dredged. If this be so, the channel of the river has greatly depreciated since the dams were erected.

Negotiations are now pending between the Sanitary District and the Canal Commissioners in which the conditions governing the removal of the dams are to be stipulated and a consent decree entered.

14. *The Joint Resolution of 1889* declares the policy of the State and interprets the contemporary Sanitary District and Waterway legislation. The United States is requested to aid in the construction of a channel not less than 22 feet deep across the Chicago Divide, between Lake Michigan and Lake Joliet, and to project a channel of a depth of not less than 14 feet, thence to La Salle, "all to be designed in such manner as to permit future development to a greater capacity"; and to stop work upon the locks and dams at La Grange and at Kampsville, and to apply its funds "in such manner as to develop progressively all the depth practicable by the aid of a large water supply from Lake Michigan at Chicago." "It is the policy of the State of Illinois to procure the construction of a waterway of the greatest practicable depth and usefulness for navigation from Lake Michigan via the Desplaines and Illinois Rivers to the Mississippi River, and to encourage the construction of feeders thereto of like proportions and usefulness."

> *The Waterway Bill* of 1895 states: "That it is hereby declared to be the policy of the State of Illinois to procure, as soon as practicable, the construction of a deep waterway through the State from Lake Michigan via the Desplaines and Illinois Rivers, to the Mississippi River, of such dimensions and capacity as to form a homogeneous part of a through route from the Atlantic Seaboard via the Great Lakes to the Gulf of Mexico; and it is hereby declared to be the further policy of the said state to determine such a system of lateral and subsidiary waterways as shall be permitted by topographical and hydrographical conditions, in order that the state may, by appropriate legislation, fully conserve the public interests in said system, to the end that the same may be developed with the growth in resources and population, as public necessities shall demand."

The bill provided for a project "of a depth of not less than 14 feet * * * so designed as to permit future increase in depth," and looked to the enlargement of the Drainage Canal as a harbor for Chicago. It passed the Senate with four dissenting votes and the House with one dissenting vote, and was vetoed by Governor Altgeld June 20, 1895, after the adjournment of the General Assembly.

The Joint Resolution of 1897 recites the intervening facts and repeats and elaborates the joint resolution of 1889, and the United States is requested to co-operate in the development of the river between the end of the Drainage Canal and the head of the alluvial valley at Utica and to remove the dams at La Grange and Kampsville when the water supply is turned in and the State dams removed at Henry and Copperas Creek.

A Permit was issued to the Sanitary District of Chicago by the Secretary of War, to cut down the crests of the Federal dams at La Grange and Kampsville by two feet, under the Joint Resolution of Congress, approved April 21, 1904, and the work has been carried out at Kampsville.

"Fourteen Feet Through the Valley" as a preliminary depth promoted by the Lakes-to-the-Gulf Deep Waterway Association, has its origin in the foregoing declarations.

15. *The Waterway Amendment to the State Constitution* was considered at an adjourned session of the General Assembly and submitted to the vote of the people October 16, 1907, by an unanimous vote in each house. The people voted thereon at the general election November 3, 1908, and adopted the same by a vote of 692,522 as against 195,177, out of a total vote of 1,169,330. The question submitted was: "Amending separate section of the Constitution relating to the canal so as to authorize the issue of bonds not to exceed $20,000,000 for the construction of a deep waterway along a route between Lockport and Utica and for the equipment and maintenance of dams, locks, bridges and power plants for the development and utilization of water power,'' the same being an epitome of the amendment.

The Internal Improvement Commission was constituted by act of the General Assembly in 1905, for the purpose of developing the waterway policy of the State, and was inspired by the Waterway Bill of 1895. (See Topic 12.) The report of the Commission was submitted to the Governor February 27, 1907, and transmitted to the General Assembly April 10, 1907, and constituted the basis of action at the adjourned session.

The report projected four levels between Lockport and Utica, a distance of sixty-one miles, the Joliet level to have a depth of 24 feet at the outset, and the other levels to have a preliminary depth of 14 feet, to be developed progressively by dredging, all structures to be based on an ultimate depth of 24 feet, and public ownership of the water power incidentally created was recommended. It was proposed to remove the dams and to dredge the Lower Illinois so as to restore substantially the natural low water level in the interest of the agricultural and sanitary welfare of the valley. The water power estimate was based on an increment of 14,000 cubic feet of water per second from Lake Michigan, together with the low water flow of the stream, and, including that of the Sanitary District at Lockport, amounted to 173,000 horse-power on the turbine shaft for the ultimate channel development. In a statement issued to the people October 23, 1908, the capacity of the Illinois and Michigan Canal, taken at 1,000 cubic feet per second, is added to the flow by the undersigned.

The Promoters of the Constitutional Amendment contemplated co-operation by the United States to the extent of constructing the five locks and the improvement of the Lower Illinois River, and perhaps the caring for the bridge problems; in other words, the $20,000,000 bond issue was not considered adequate to more than the acquisition of the right of way, the development of the channel, the construction of the dams, the development of the water power, and possibly the bridge problems, and were so advised by the undersigned; so the amendment was projected and passed on the theory of Federal co-operation.

Legislation to make available the $20,000,000 has been proposed at all regular and special sessions during the past three years, but the General Assembly has steadfastly adhered to the policies referred to in the three foregoing numbers and has been reluctant to enter upon the work without an agreed plan of co-operation with the United States and until the public right in the stream covered by the constitutional amendment has been finally adjudicated in the court of last resort, as set forth in the next topic.

16. *The Right of the People* in the part of the stream covered by the Constitutional Amendment is in process of adjudication, under "An Act recognizing the Desplaines and Illinois Rivers as navigable streams, and to prevent obstructions being placed therein, and remove obstructions therein now existing," approved and in force December 6, 1907. A test case was brought and decided by the Supreme Court of the State October 26, 1909, in part adversely to the people. The General Assembly by act in force July 1, 1911, ordered an appeal to the Supreme Court of the United States. Meantime, December 14, 1909, a bill covering the same issues in part was filed in the U. S. Circuit Court at Chicago by the U. S. District Attorney on authority of the Attorney General of the United States. The evidence has been taken and the case is ready for submission. It is presumed the issues in both cases will reach the Supreme Court in the course of a year.

17. *The United States* has authorized examinations and reports respecting the Deep Waterway as follows:

(*a*) The Act of Congress, August 11, 1888, provides for a project and estimate upon a waterway "not less than 14 feet deep" between Lockport and La Salle. The report was submitted March 11, 1890, and after the Sanitary District of Chicago had been authorized and organized. The report breathes a spirit hostile to the Illinois program, and adverse to co-operation.

(*b*) *The Barlow Board* was authorized by Act of March 3, 1899, and was instructed by Act of June 6, 1900, to determine the feasibility of a 14-foot waterway between Lockport and the Mississippi River, and in its report of November 18, 1900, the same was declared feasible and a gross limit of cost given. (H. R. 220, 56th Cong., 2d Ses.)

(*c*) *The Fourteen-Foot Board,* otherwise known as the Ernst Board, constituted under the Act of June 13, 1902, made an elaborate survey of the valley between Lockport and the mouth, and together with the Mississippi River Commission, submitted a project for a waterway with a depth of 14 feet between the end of the Drainage Canal at Lockport and the City of St. Louis, under dates February 28th and August 26, 1905. (H. R. 263, 59th Cong., 1st Ses.) This report is very complete, and submits plans with estimates of cost. Among other things it says (page 18):

> "The additional flow provided by the Chicago Drainage Canal is now 4,200 cubic feet per second. It will allow the removal of the present locks and dams, and it makes practicable the maintenance of an open channel considerably deeper than the seven feet now provided by those structures. The increase to 10,500 cubic feet makes practicable a still larger open channel."

And again (page 11):

> "In a future not remote, larger amounts of water may be needed for sanitary purposes, and channels deeper than 14 feet will then become practicable in the open alluvial section of the Illinois River."

(*d*) *A Special Fourteen-Foot Board* was constituted under act of Congress March 2, 1907, to report upon the Mississippi River between St. Louis and the mouth, and incidentally on the route from Lake Michigan to St. Louis, and submitted its report March 20, 1909. (H. R. 50, 61st Cong., 1st Ses.) Several projects for a depth of 14 feet were reported feasible and the costs estimated, and this Board, known as the Bixby Board, adopted the estimates of the Ernst Board for that part of the route between Lake Michigan and St. Louis.

(*e*) *"A Special Board of Engineers* upon a

Waterway from Lockport, Illinois, by way of the Desplaines and Illinois Rivers, to the mouth of the Illinois River, and certain related subjects," was constituted under act of Congress of June 25, 1910. This Board is to report upon a plan of co-operation with the State of Illinois, but the state has not yet provided any agency for such purpose. It was also to report upon certain dams in the Mississippi River between St. Louis and Cairo, and upon the effect of diverted water upon the levels of the rivers, and also upon the levels of the lakes, and remedies for the same. In his message of December 21, 1911, the President of the United States recommended to the Congress that this Board be continued until Illinois should be able to respond and the labors of the Board be concluded. (See Topic 18.)

Four Federal Reports, three by Boards of Engineers, each within the limits covered, have determined the feasibility of a 14-foot waterway produced by the aid of a water supply from Lake Michigan. The fourth board is to make the fifth report upon procedure in co-operation with the State of Illinois, and upon an alternative plan for the Middle Mississippi River, and is to re-examine the lake level problem.

18. *The President's Message* of December 21, 1911, contains the following:

> "WATERWAY FROM THE LAKES TO THE GULF."
>
> "The project for a navigable waterway from Lake Michigan to the mouth of the Illinois River, and thence via the Mississippi to the Gulf of Mexico, is one of national importance. In view of the work already accomplished by the Sanitary District of Chicago, an agency of the

> State of Illinois, which has constructed the most difficult and costly stretch of this waterway and made it an asset of the nation, and in view of the fact that the people of Illinois have authorized the expenditure of $20,000,000 to carry this waterway sixty-two miles farther to Utica, I feel that it is fitting that this work should be supplemented by the Government, and that the expenditures recommended by the Special Board of Engineers on the waterway from Utica to the mouth of the Illinois River be made upon lines which, while providing a waterway for the nation, should otherwise benefit the State to the fullest extent. I recommend that the terms of service of said Special Board of Engineers be continued, and that it be empowered to reopen the question of the treatment of the Lower Illinois River, and to negotiate with a properly constituted commission representing the State of Illinois, and to agree upon a plan for the improvement of the Lower Illinois River and upon the extent to which the United States may properly co-operate with the State of Illinois in securing the construction of a navigable waterway from Lockport to the mouth of the Illinois River in conjunction with the development of water power by that State between Lockport and Utica."

19. *The Lakes-to-the-Gulf Deep Waterway Association* is representative of all the interests concerned in a deep waterway between the Great Lakes and the Gulf of Mexico, and was organized and held its First Annual Convention in the autumn of 1906. Its program was to promote a navigable channel with a depth of not less than 14 feet, expressed in the sentiment, "Fourteen Feet Through the Valley," thus adopting the official policy of the State of Illinois, as outlined in 1889. The organization of the movement had been deferred owing to the case of "The State of Missouri *vs.* the State of Illinois and the Sanitary District of Chicago," which was decided by the Supreme Court of the United States early in 1906, and is hereinafter referred to (Topic 41). Each annual meeting of the Association has been attended by several thousand delegates. At the Fifth Annual Convention, held at St. Louis November 25-26, 1910, "Declaration of Principles and Purposes," Section 6, contains the following:

> "Impressed by the fact that all our canals as first projected or constructed have been found too small to meet the commercial needs of later generations, we agree that any waterway improvements now undertaken should be planned to meet prospective no less than present requirements; we demand that the plans for a waterway connecting the Great Lakes with the Gulf as the main artery of our navigation system provide for an initial depth of not less than fourteen (14) feet, with lock sills and other permanent structures adapted to a depth of not less than twenty-four (24) feet."

The Sixth Annual Convention at Chicago, October 12-14, 1911, reaffirmed the program adopted at St. Louis in 1910.

"Association of Drainage and Levee Districts of Illinois" is representative of some 400,000 acres of overflow lands in the Lower Illinois Valley which are now under reclamation. At its Second Annual Meeting, Springfield, Ill., January 10, 1912, it endorsed the Deep Waterway in the interest of Reclamation and Sanitation, and resolution No. 9 declares as follows:

> "The great interests which we represent are interests of conservation, and these interests require the immediate removal of the dams in the

> Lower Illinois River and the dredging of the stream bed to the largest capacity which can be justified. In this object we ask the co-operation of every interest which is concerned in the development of our resources, and we are ready to co-operate with every other agency which has for its object the production of deep water through the Illinois valley by means of dredging in an open channel in conjunction with the water supply from Lake Michigan."

Every Interest of Reclamation between Lake Michigan and the Gulf of Mexico is demanding a stable and deep channel, such as will be produced by the development of a deep waterway in conjunction with the water supply from Lake Michigan.

20. *The Population* immediately concerned in the deep waterway, and within ten miles thereof, in the State of Illinois, and at the southwest angle of Lake Michigan, is as follows:

Sanitary District of Chicago, 358.1 square miles	2,311,810
Northwestern Indiana, 47.5 square miles	64,948
Illinois River, ten-mile limit	445,828
Mississippi River, ten-mile limit	197,065
Total, Illinois and N. W. Indiana	3,019,651

The Population of the Sanitary District of Chicago, together with the urban population, in communities of 2,500 and upwards, in Northwestern Indiana and adjacent to the water route, between the Sanitary District and the Gulf, is as follows:

Sanitary District of Chicago	2,311,810
Indiana (Hammond, Whiting, East Chicago and Gary)	63,412
Illinois Valley, urban	208,679
Total	2,583,901

Mississippi River, mouth of Illinois to Gulf	1,346,648
Total, Lake Michigan to Gulf	3,930,549
The additional urban population of the Illinois River Basin is	158,652

21. *The Evolution of the Sanitary Project* underlying the law is historically treated in Topic 39. The Drainage and Water Supply Commission of 1886-7 made no final report, but the preliminary report of January 30, 1887, set forth at some length three alternative methods of sewage disposal. These are presented below, together with a statement respecting the art and the genius of the dilution method as developed by actual experience in the Illinois Valley.

First. Land disposal by sewage farming and intermittent filtration. The lands available were largely in the adjacent State of Indiana and remote from the central district; sewage collectors and interceptors, conduits and pumping, were required; a fraction of the storm water only was provided for, and the extensive river harbor was left without circulation. The scheme was prohibitive on account of diverse political jurisdiction, excessive first cost and cost of maintenance and operation.

Second. Lake disposal by diffusion, well out from shore, and shifting the location of water supply, to be followed later by clarification through treatment and sedimentation. The sewage was to be put into the lake opposite Hyde Park (South Park), and the water supply shifted to Grosse Point (Evanston); otherwise, the system was the same as for land disposal, and only less costly.

Third. Dilution beyond offense by means of canal to Illinois Valley. This canal was to have a capacity of not less than 600,000 cubic feet of water per minute and be sufficient to keep all flood water from the lake, and all sewage was to be intercepted from the lake and the river harbor circulated by means of auxiliary works. The Desplaines River and the North Branch were to be diverted to the lake north of the city, and a Calumet branch canal with a capacity of 60,000 feet per minute, was added. This project met all the conditions, the initial cost was less, and the cost of maintenance and operation was comparatively nominal. It had also collateral advantages, as an extension of the harbor, a contribution to the waterway, and in water power.

The Findings confirmed prior determinations, and have been amply verified by time and experience. Artificial methods have not realized the sanguine expectations of their promoters, and are not now recommended except as a dernier sanitary recourse or for special or concentrated effluents. Modern plumbing and sewerage by water carriage have come to stay and do not lend themselves to the economic recovery of valuable fertilizing products, and such attempts have been practically abandoned. Land disposal is applicable to regions of deficient rainfall and mild climate, and as an auxiliary to other methods, and the suggestion by the Commission of its local application to the Calumet district has not found recent favor. Chemical treatment and sedimentation are ameliorative and partial only. The latest and most authoritative opinion upon the subject-matter is the report of the Sewerage Commission of the

City of Milwaukee (April 25, 1911), a characteristic lake city. After the best has been done through treatment and diffusion in the lake at a distance from shore and water intake, circulation must be maintained in the rivers, and the water supply filtered, and then carefully watched and chemically treated when occasion requires. No severer indictment of the present state of the art of sewage disposal can be framed than is contained in this report upon the expedients which must be resorted to to insure the purity of the Milwaukee water supply, and in this case it is a question whether civil service methods will result better than they have in other complex and scientific adventures in the field of artificial sewage disposal and water purification. In view of current misinformation, the rationale of the dilution method is further elaborated.

Fish Culture in China is referred to as follows in King's recent book, "Farmers of Forty Centuries," pages 93-5:

> "It is a common practice, too, among the fish growers to fertilize the ponds. * * * Fish reared in the better fertilized ponds bring a higher price in the market. The fertilizing of the water favors a stronger growth of food forms, both plant and animal, upon which the fish live, and they are better nourished, making a more rapid growth, giving their flesh better qualities, as is the case with well fed animals."

Deep and permanent fish basins rent as high as $30 gold per acre. It may be added that some lakes in rocky and sterile regions are so pure, so free from organic or fertilizing matter, that they contain little fish life. A study of the great sea fisheries in their relation to land waters and ocean currents is suggestive in this connection.

Illinois River Waters in proportion to extent are by far the richest fisheries in the United States, apart from the sea. The catch was some eight to nine million pounds when the Sanitary District Act was passed in 1889, and ranged from six to fourteen million pounds up to the opening of the Drainage Canal in 1900, but it was uncertain and fish life was occasionally decimated by extreme drought, stagnation and prolonged ice cover, which exhausted the oxygen content of the water. Since the opening of the Drainage Canal the fisheries have become an important and reliable industry, the catch having risen to 46,000,000 pounds, with a value of over $800,000, on the banks (census for 1908). This represents over $10 per acre on all the water area of the Illinois Valley, and the value is doubled to the consumer. With a better and more ample water supply the crop will improve in quality and grow exceedingly. Fish life means such a surplus of oxygen content as will insure against offensive decomposition, and the significance thereof is recognized in the opinion of the court in the Missouri case. (See Topic 41.) This matter was appreciated, and the Sanitary District Act supported by the Fish Commissioner of Illinois, S. P. Bartlett, who has devoted most of his life to the development of fisheries and added greatly to the wealth of the State.

Chicago Has Utilized and developed the most successful sewage farm in the world, automatic in action and making a large return, and without sacrifice of the organic wastes as in other methods of sewage disposal. Twenty-five years ago the men with scientific insight who promoted the dilution method were denounced as "barbarians" by erudite persons who admitted their own scientific attainments, and through whom much capital has been sunk without commercial success. Recent criticism is milder, but it may be no less archaic.

C. The Great Lakes.

22. *The Great Lakes Above Niagara,* in relation to Water Surface and Drainage, are exhibited in characteristic divisions as follows (Rpt. U. S. Deep Waterways Com., 1896, Exhibit B3, and Lake Survey Bulletin No. 21, 1912):

	Waterways Com. 1896.			Lake Surveys 1912.		
Lakes.	Water Surface. Square Miles.	Water-Shed. Square Miles.	Basin. Square Miles.	Water Surface. Square Miles.	Water-Shed. Square Miles.	Basin. Square Miles.
Superior.....	31,800	48,600	80,400	32,060	44,074	76,134
Mich.-Huron.	45,600	97,800	143,400	45,314	92,493	137,807
St. Clair.....	495	6,320	6,815	503	5,691	6,194
Erie.........	10,000	24,480	34,480	9,968	24,605	34,573
Totals.....	87,895	177,200	265,095	87,845	166,863	254,708

The above areas as given by the Commission are divided between the United States and Canada approximately, as follows:

	U. S.	Canada.
Water surface	56,257	31,638 square miles
Watershed	101,380	75,820 square miles

Lake Ontario and the Saint Lawrence River to the head of the Galop Rapids is exhibited as follows:

	Water Surface.	Water-Shed.	Basin.
	Square Miles.		
Waterways Com., 1896....	7,450	25,530	32,980
Lake Survey, 1912........	7,243	25,737	32,980

The watershed, as given by the Commission, lies in the State of New York 14,275 square miles, and in the Province of Ontario 11,255 square miles.

The Outflow of the several Great Lakes for the period of fifty-two years, 1860-1911, as deduced from two authorities, is given below.

The International Waterways Commission (Regulation of Lake Erie, 1910) has tabulated the mean monthly discharge in the several outlets for the forty-eight years, 1860-1907, and these have been extended to 1908-11, and the average for the full period has been entered below.

The Survey of Northern and Northwestern Lakes (Bulletin No. 21, 1912) gives the volumes under the conditions of 1911, equivalent to the mean stage of the several lakes for fifty-two years, and the same is entered below; the mean elevation of the surface of the several lakes, by the old levels, and the adjusted levels of 1903, is also entered.

	Mean Elev. Above Sea Level.		Outflow in Cu. Ft. per Sec.		Remarks.
Lakes.	Old Levels.	New, 1903.	Commission.	Lake Survey.	Vol. Taken at
Superior....	601.72	602.28	81,300	76,000	St. Mary's Falls
Mich.-Huron.	580.90	581.25	....	208,000	St. Clair River
St. Clair.....	....	(575.36)	203,300	(213,000)	Detroit River
Erie........	572.65	572.56	211,300	212,100	Niagara River
Ontario.....	246.24	246.18	253,300	243,000	St. Lawrence River at Galop Rapids

The Niagara River outflow, by the Commission, includes 1,000 feet by the Erie Canal and 1,100 feet by the Welland Canal, and the same amounts have been added to the Lake Survey figures. The figures above in parentheses are based on data by Lake Survey in report Chief of Engineers U. S. A., p. 2720, 1910.

The diversion for the Chicago Drainage Canal averages 4,800 feet for the twelve years, 1900-11, which is the equivalent of 1,100 feet additional for fifty-two years for all the outlets except St. Mary's River.

The average volume deduced from monthly means should exceed the volume for the mean stage as the plus increments for stages above the mean are greater than the minus increments from like stages below.

The Lake Survey figures correspond to present outlet conditions, while the Commission figures cover the period of change from natural to present conditions.

The Outflow Variations are made up from the tables, extended to 1911, of the International Waterways Commission (Rpt. Regulation L. Erie, 1910), and are as follows (in cu. ft. per sec.):

Locality.	Maximum Year.	Minimum Year.	Maximum Month.	Minimum Month.
St. Mary's River	101,100	65,100	128,700	48,200
Detroit River	234,400	173,600	275,400	105,300
Niagara River	238,700	180,400	257,800	168,700
St. Lawrence River at Galop Rapids	303,400	191,600	351,200	152,200

The Mean Annual Run-Off at Niagara is 0.8 cubic feet per second per square mile, representing a depth of 10.87 inches over the Basin.

The Volume of Water stored in the Upper Great

Lakes would supply the average rate of flow at Niagara for about 150 years, or would provide for a flow of 15,000 second feet at Chicago for over 2,000 years.

The Normal Precipitation for the several Lake Basins was deduced in 1899 by the U. S. Weather Bureau from the records in the United States and Canada, and these determinations have since been used in the bulletins of the U. S. Lake Survey, and are as follows: Lake Superior, 28 inches; Lake Michigan-Huron (Ave.), 32.5 inches; Lake Erie, 36 inches, and Lake Ontario, 33 inches. (See Topic 27.)

This study disclosed the fact that the precipitation on the Canadian watersheds was generally less than that for the watersheds in the United States.

The relation of precipitation to water supply and outflow has not been comprehensively studied, but several partial investigations have shown their mutual dependence.

The Elevations of the Several Great Lakes above mean tide of the Atlantic Ocean at Sandy Hook are based on levels taken by the U. S. Coast and Geodetic Survey and the U. S. Lake Survey, and were published in the final report of the U. S. Lake Survey in 1881. New determinations have been made, known as "The Adjustment of 1903," and published by both Surveys, and these have since been used. The U. S. Deep Waterways Commission, 1896, determined the low water plane of 1847 for Lake Michigan-Huron (see Topic No. 6), and the equivalent thereof for the other Lakes, and adopted the same as Standard Low Water, and the high water of 1838 was adopted as Standard High Water. The elevations for these standards as used before and since the adjustment of 1903 are as follows:

Lakes.	Prior to 1903 S. L. W.	S. H. W.	Since 1903. S. L. W.	S. H. W.
Superior	600.68	604.76	601.24	605.32
Michigan-Huron	579.60	584.34	579.95	584.69
Erie	571.35	575.20	571.26	575.11
Ontario	244.53	249.04	244.47	248.98

The Low Water of 1847, at Chicago, is also determined by means of the levels taken by the Georgian Bay Ship Canal Survey, 1904-7, between Lake Ontario at Toronto and Georgian Bay at Collingwood, in connection with the U. S. determinations from mean tide of the Atlantic Ocean to Oswego. This elevation is further determined from mean tide of the Gulf of Mexico at Biloxi, Mississippi, by the levels of the Mississippi River Commission, and of the Ernst Board, report of 1905. The several determinations are as follows:

Determination of	Elevation of Chicago Datum
Levels prior to 1903	579.60 ft.
Adjustment of 1903	579.95 ft.
Combined American and Canadian Levels of 1903 and '07	579.49 ft.
Levels from the Gulf of Mexico	579.70 ft.

It appears from the foregoing that the final adjustment has not been made.

The map hereto attached exhibits the basin of the Great Lakes and is Exhibit 10 of the Lakes-to-the-Gulf Deep Waterway series.

23. *The Limiting Natural Depths* in the intermediate channels of the Great Lakes and in the Saint Lawrence River were: Between Lake Superior and Lake Huron, except rapids in St. Mary's River, about 9½ feet; between Lake Huron and Lake Erie, at the St. Clair Flats, 9½ feet, and at the Lime-Kiln Crossing near the mouth of the Detroit River, 13 feet; on Horseshoe Reef at the head of Niagara River, 17 feet in a sinuous channel; in the Saint Lawrence River between Ogdensburg and Montreal, 6 to 8 feet on rapids, and 11 feet between rapids; between Montreal and Quebec, on the flats of Lake St. Peter, 10½ feet. These natural depths determined early canal projects. After the Canadian Union in 1841 a systematic project was adopted for a depth of nine feet between Lake Erie and Montreal. The four Saint Lawrence canals were opened at various dates between 1843 and 1848, and the enlarged Welland Canal was opened in 1848 and increased to 10 feet in 1853. The Illinois and Michigan Canal was surveyed and projected by U. S. Engineers in 1829-30 and 1834 for a depth of 10 feet,

and in 1838 General Dearborn writes from Chicago that the canal is to be "of such enlarged dimensions as to permit the passage of large vessels, being 10 feet deep."

Deeper Channels were initiated by Mr. Charles P. Harvey, who promoted, designed and constructed the original canal at Sault Ste. Marie for a depth of 12 feet in 1852-5 for a land grant to the State of Michigan from the United States. The St. Mary's River and the St. Clair Flats were deepened to 12 feet in 1858, and in 1867-71 St. Clair Flats Canal was built for a depth of 13 feet, thus corresponding to the depth on the rocky shoals near the mouth of Detroit River. After the confederation of the Provinces as the Dominion of Canada, in 1867, the depth of 12 feet then available at ordinary low water for Upper Lake navigation was determined upon, in 1871, for the enlarged canals between Lake Erie and Montreal, with locks 270 feet long and 45 feet wide, and in 1875 the projected depth was increased to 14 feet, or all that was available between the several rapids of Saint Lawrence River without extensive improvement.

The Welland Canal was opened for 12 feet in 1883, and for 14 feet in 1887. The Saint Lawrence Canals were not all completed so as to give a depth of 14 feet for through nagivation until 1899. The depths in the Canadian Canals were based on low water rather than mean stages, as used in the United States improvements, and the completion of the canals was delayed by railway colonization development which absorbed the financial resources of the Dominion.

The Scale of Upper Lake Navigation was increased to 16 feet by the deepening of the Lime-Kiln Crossing of the Detroit River and the St. Clair Flats Canal in 1873-4, the opening of the Weitsel Lock at Sault Ste. Marie in 1881, and the deepening of St. Mary's River in 1883.

The Present Scale of Lake Navigation was initiated by betterments and deeper channels at localities, and by 1891 the Lime-Kiln Crossing of Detroit River had a depth of 20 feet for a width of 440 feet, St. Clair Flats Canal had been deepened to 18 feet for a width of 200 feet, Hay Lake Channel in the St. Mary's River for a depth of 20 feet was partially completed, and the new lock at Sault Ste. Marie for a depth of 21-2 feet, authorized in 1886, was in progress. The project of 1891 was for "a ship channel 20 feet in depth and of a suitable width in the shallows of the connecting waters of the Lakes between Chicago, Duluth and Buffalo," an increase of four feet in the prevailing depth for navigation. This project was authorized by the Act of July 13, 1892, and provided for channels in St. Mary's River, 300 feet wide and 21 feet deep; Lake Huron approach to the St. Clair River 2,400 feet wide and 21 feet deep; in St. Clair Flats Canal 20 feet deep for the full width of 300 feet; in Lake St. Clair approach to Detroit River 800 feet wide by 20 feet deep, and at mouth of Detroit River 800 feet wide by 21 feet deep.

These improved channels became available in 1895 and were substantially completed in 1897, but betterments continued until covered by later projects. The new lock at Sault Ste. Marie, known as the

"Poe Lock," was opened in 1896. Meantime, the Canadian Government had constructed a lock somewhat greater in depth on the Canadian side of the rapids, and opened the same in 1895. The Niagara improvement, for a depth of 18 feet and a width of 400 feet between Lake Erie and Tonawanda, was also available.

Standard Low Water is the low water of 1847 (mean of eight months, April to November) for Lake Michigan-Huron and the equivalent thereof for the other Lakes and intermediate channels, as determined by comparison of the records of Lake Levels for the thirty-six years, 1860-95. The improvements and structures above described are referred to various local datums at or near Mean Lake Level. The depths available at Standard Low Water were as follows:

Sault Ste. Marie	Platform of Poe Lock		19.89 feet
Sault Ste. Marie	Floor Canadian Lock		20.14 feet
St. Mary's River	Hay Lake Channel		17.9 feet
St. Clair Flats Canal			18.8 feet
Detroit River	Lime-Kiln Crossing		19.3 feet
Niagara River	Lake Erie to Tonawanda		17.0 feet
Welland Canal	Port Colborne		13.72 feet
Welland Canal	Port Dalhousie		14.33 feet
St. Lawrence Canals	Upper and Lower Mitre Sills		
	Galop	14.75	..... feet
	Rapide Plat	15.18	15.93 feet
	Cornwall	15.02	14.71 feet
	Soulanges	16.18	16.18 feet
	Lachine	14.46	17.93 feet

(See Rpt. of U. S. Deep Waterways Com., 1896, p. 97 *et seq.*, and also pp. 91-6.)

A New Scale of Lake Navigation was projected in 1899 and 1900 and authorized by Act of June 13, 1902. The project of 1899 provided for a second canal also 300 feet wide at St. Clair Flats with an intermediate sand dike 100 feet wide, and this work was completed in 1906. The project of 1900 provided for a channel 600 feet wide and 21 feet deep at a minimum stage in Lower Detroit River, covering Ballards Reef, Lime-Kiln Crossing and other obstructions, and this project was amended, and a second channel provided for a depth of 22 feet and a width of 300 feet, by the Acts of 1905, 1907 and 1910. The original channel known as the "Amherstburg Channel" east of Bois Blanc Island, had been nearly completed at the end of 1911, a few patches remaining above grade at Ballards Reef and other points. The second channel, known as the "Livingstone Channel," west of Bois Blanc Island, is to be opened in 1912 (opened October 19th), and has been widened to 450 feet, for a length of about one mile opposite the island.

The project of 1900 for St. Mary's River, between the locks and Lake Huron, provided for single channels 600 feet wide, or double channels, each 300 feet wide, and, as amended from time to time, minimum depths of 21 and 22 feet. These channels have been substantially completed for 21 feet with 22 feet at Middle Neebish, and in progress and partially available at Sailors Encampment.

The Standard Improvement Plane governing recent work on St. Mary's River corresponds to 18 feet on platform of the Poe Lock, and 18.25 feet on floor of the Canadian Lock, and is 4 feet below improvement plane for the project of 1891-2; and at Lake Huron corresponds to low water of December, 1895, which is 2.45 feet below the old plane, and the new declivity is 1.57 feet (Report of 1911 gives plane 0.17 foot lower at locks and 0.20 foot lower at Lake

Huron and declivity 1.60 feet). The plane governing recent improvements in Detroit River corresponds to a Lake Erie level 0.30 foot above the low water of November, 1895, and is 1.51 feet below the improvement plane used in the project of 1891-2. No further project has been adopted for deeper channels between the foot of Lake Huron and head of Detroit River, and the improvement plane is the same as for the projects of 1891-2, but the present depths referred to the new plane would be approximately as follows: Lake Huron approach to St. Clair River, 18.9 feet; St. Clair Flats Canal, 18.3 feet, and Grosse Pointe channel, 18.3 feet. (The new plane, at the head of the St. Clair Flats Canal, is approximately 5 feet below Lake Huron and 3 feet above Lake Erie, and 0.3 foot lower for Lake St. Clair.)

Standard Low Water, determined in 1896 (U. S. Deep Waterways Commission), is above the new reference plane as follows: St. Mary's River at the locks, 1.89 feet; Lake Huron, head and foot, 0.95 foot; St. Clair Flats and Grosse Pointe, approximately 0.50 foot, and Lake Erie, 0.26 foot. The standard low water at the locks is no longer valid by reason of radical channel improvements below, and a change of base level for Lake Michigan-Huron is stated by the Board of Engineers on Deep Waterways, 1900.

The Relative Depths under the project of 1900-2, as amended in 1905-7, and the project of 1891-2, referred to the present improvement plane, are as follows:

Point.	1900-2 and 1905-Ft.	1891-2 Ft.
St. Mary's River below locks...	21-22	16.0-17.0
St. Mary's River at Lake Huron.	21-22	17.55-18.55
Approach to St. Clair River.....	18.9	18.9
St. Clair Flats Canal...........	18.3	18.3
Grosse Pointe Channel..........	18.3	18.3
Lower Detroit River.............	21-22	18.5-19.5

In addition to the increase in depth shown above, the minimum widths of channels have been doubled in St. Mary's River, and in St. Clair Flats Canal, the Amherstburg channel in the lower Detroit River has been increased by thirty-six per cent. (36%), and the Livingstone channel has been added.

The Ocean Port of Montreal has been made by the progressive deepening of the St. Lawrence River above Quebec, from a natural depth of 10½ feet.

In 1852 the depth has been increased to 15 feet,
In 1857 the depth has been increased to 18 feet,
In 1865 the depth has been increased to 20 feet,
In 1878 the depth has been increased to 22 feet,
In 1882 the depth has been increased to 25 feet,
In 1888 the depth has been increased to 27½ feet,
In 1911 the depth has been increased to 30 feet,
except three bars near Quebec which carry 30 feet at high tide, and the project for 35 feet has been entered upon and eight miles completed below Montreal.

The Deepened Channels below Montreal aggregate a length of seventy miles and will be greatly increased for the depth of 35 feet now in progress. The aggregate length of the deepened channels between Buffalo, Chicago and Duluth is now between twenty-six and twenty-seven miles, and this will be increased to between thirty-nine and forty miles when the channel between Lake Huron and Detroit River is put down to 21.0 feet below the present reference plane.

24. *The Davis Lock and Canal* now under construction at Sault Ste. Marie was projected in 1906, and authorized by Act of March 2, 1907, and is to have a length between quoins of 1,350 feet, a width in chamber of 80 feet, and an available depth of 24.5 feet below the new plane of reference for the improvement of the St. Mary's River below the locks. This plane of reference corresponds to and is at an elevation of 1.57 feet above the low water of December, 1895, in Lake Michigan-Huron, and represents a depth of 18 feet on the platform of the Poe Lock, and 21 feet in the improved channels of the St. Mary's River; in other words, the depth of the Davis lock is 6.5 feet greater than that of the Poe lock and 3.5 feet greater than the present channels of St. Mary's River. The new lock and canal is located adjacent on the north to the old lock and canal.

The Chicago Datum Plane is the low water of 1847 (see Topic No. 6), and is 0.95 foot above the low water of December, 1895, or 0.62 foot (1.57—0.95) below the new plane of reference for St. Mary's River below the locks. When the connections with Lake Michigan are completed, the Drainage Canal will have a capacity of 14,000 cubic feet of water per second, and a depth of 24.4 feet, with the lake level at the plane of 1847. The depth in the Davis lock will be identical when the water stands 0.10 foot below the new reference plane, or when the slope in St. Mary's River is 0.52 foot or one-third that of the present improvement plane (1.57 feet) and the depths will remain identical at all stages for such slope. To fully utilize the Davis lock, channels in the St. Mary's River must be deeper by some four feet, and have greater widths for larger vessels and for the growth of commerce. The declivity may thus reduce to the limit above stated for identical depths. So singular and happy a coincidence suggests unconscious cerebration.

Still Deeper Channels are predicated by the Davis lock, some 4 feet additional for St. Mary's River, as already stated. If the declivity in St. Mary's River be lessened by 1 foot, the corresponding channels in the lower Detroit River will be 2 feet deeper for the Livingstone channel and 3 feet deeper for the Amherstburg channel, or less for some higher reference plane, due to the control of the level of Lake Erie. The channels between the foot of Lake Huron and the head of Detroit River must be correspondingly deepened or have depths 5.7 feet greater than the present channels. Such deeper channels presume compensation works that will maintain present reference planes. The aggregate length of these deeper channels will be about fifty miles, or 70 per cent. of the length already deepened in the improvement of the St. Lawrence River below Montreal, so that deeper and broader channels are not a matter of embarrassment to the National resources. Channels 30 feet deep would aggregate about seventy-one miles or the same as in the St. Lawrence below Montreal (Report U. S. Deep Waterways Commission, 1896).

The Lock History at Sault Ste. Marie illustrates the growth of commercial needs and changes in physical conditions. The following tabulation gives leading dimensions, depths for which locks were built, and the present depths below the new reference plane:

Name of Lock.	Year opened.	Dimensions. Feet.	Original depth. Feet.	Depth for new plane. Feet.
Harvey	1855	350x 70	12.00	8.00
Weitzel	1881	515x 80	17.00	12.33
Canadian	1895	900x 60	22.00	18.25
Poe	1896	800x100	22.00	18.00
Davis	under constn.	1,350x 80	24.50	24.50

The original locks of 1855 were on the site of the present Poe lock and were put out of use in 1888 by its construction, and the Davis lock is under construction. The other three locks are in use.

25. *Changes in Lake and River Levels* are recognized in official documents, but specific statement and discussion are meager. Improved channels may be as effective in reducing water levels as the actual diversion of water, and in addition may greatly change the slopes in connecting channels.

St. Mary's River has now a declivity of 1.57 feet, or about one-half that of the plane contemporary with the construction of the Poe lock, which was 3.12 feet, and which has been lowered by 4 feet at the locks and 2.45 feet at Lake Huron. The Weitzel lock of 1881 appears to correspond to a river plane 0.67 foot higher. Referring to compensation works, the officer in charge, General O. M. Poe, states (Report Chief of Engineers, U. S. A., 1894, p. 2370):

> "In the original plan for improving Hay Lake channel certain dikes were designed to prevent the lowering of the water in the pool below the locks when the channel was dredged through the islands to Hay Lake; likewise to prevent the lowering of the water in Hay Lake by the Middle Neebish channel. Some of the dikes were to be built under the original contracts, and the United States has built some with a dredge hired by the hour. The exact results produced by work of this character can never be predicted and some additions and changes may be found necessary after the work is completed and opened to navigation."

It appears that the effort to maintain the old plane was not effective, and that a radical change in plane is adopted for later projects. It is further apparent that a still lower plane will result from channels commensurate with the Davis lock.

The Connecting Channels between Lake Huron and Lake Erie, under the project of 1891-2, had an improvement plane with a declivity of 9.09 feet. The new reference plane for Lake Huron is 2.6 feet lower, and at Lake Erie 1.51 feet lower, and the intermediate declivity for this plane is 8 feet, or 1.09 feet less. The development of channels between Lake Huron and the head of the Detroit River, equivalent to those in the St. Mary's River and in the lower Detroit River, must be made before commerce can realize the benefits of these works. Again, the channels between Lake Huron and Lake Erie must eventually be commensurate with the Davis lock. The changes in plane that may be produced, and the remedies therefor, are matters for serious consideration.

The Detroit River Improvement, near the mouth, contemplated compensating work on the Canadian shore, but this was protested against and became the subject of an Order in Council, January 11, 1911, and such work has been abandoned.

The Niagara River has received extended improvement between Lake Erie and Tonawanda, but no mention of the effect thereof has been found in official reports. The Niagara Falls water powers are discussed at length, and effects reaching up to Lake Erie have been exhibited.

The fluctuations of Lake Erie seem to be less than those for Lake Michigan-Huron and Lake Ontario, and the earliest records seem to indicate that the low water limit has been actually raised (see Topic 26; also, levels prior to 1860, U. S. Deep Waterways Report, 1896). The development of Black Rock Harbor, by the construction of dikes and a closing dam, to Squaw Island, in connection with the Erie canal, may have constituted an actual ''compensating work'' at this locality.

The Dominion Government deepened the channel of the St. Lawrence River at Galop Rapids from 10 to 16 feet and enlarged the cross-section by 6 to 8 per cent. in 1881. These rapids control the level of Lake Ontario and the subject-matter was discussed on the assumption of a slope of 4.5 feet between the lake and the rapids, or some five times the last determination by levels of precision (Report Chief of Engineers, U. S. A., 1882). This change is not referred to or valued in the Report of the International Waterways Commission, 1910. It would represent an increase of capacity at mean stage of some nine to twelve per cent. (9% to 12%) corresponding to a lower level between 0.81 foot and 1.08 feet, but no final study has been made (see Topic 27). The Dominion Government made a further change in August, 1903, by closing the "Gut Channel," thus diminishing the capacity at mean stage by about 5.5 per cent. (Report International Waterways Commission, Regulation of Lake Erie, 1910, pp. 51-2). This represents a raise of level of nearly one-half foot by Commission discharge and increment. The Lake Survey Report for 1911 (Chief Engineers, U. S. A., p. 3018) states:

> "The discharge measurements of 1911 on the St. Lawrence River were planned to supplement those of 1908 in redetermining the relation of Lake Ontario stages and river flow which has been modified by the artificial changes in the river since the extensive series of measurements in 1900 and 1901."

A Further Omission seems to have been made by the International Waterways Commission, respecting the effect of the canal of the St. Lawrence Water Power Company between the St. Lawrence River at a point opposite and above the head of the Cornwall Canal and Grass River, at Messina Springs. This canal has been built since the Chicago Drainage Canal was started and has an average width of 225 feet, a depth of 25 feet, a cross-section of 5,625 square feet and a capacity of 25,000 cubic feet of water per second (Report of Board of Engineers on Deep Waterways, 1900, p. 413).

The diversion of such volume would lower the level at the head of the Cornwall Canal, according to the Commission rating, by 1.4 feet, and would affect the levels from Farrens Point Canal to the junction of Grass River in Lake St. Francis.

The Improvement of the St. Lawrence River for a depth of 27.5 feet produced a local lowering of water level of about one foot at Montreal (Report U. S. Deep Waterways Commission, 1896, p. 28). These channels are now broader and 30 feet deep, and are in process of deepening to 35 feet, and sensible lowering must follow.

A Permanent Lowering of the levels of Lake Michigan-Huron by about one foot, and occurring in the years 1886-90, is stated by the Board of Engineers on Deep Waterways in the report of 1900. Some 0.20 foot of such lowering is attributed to the improved channels between the head of St. Clair Flats Canal and Lake Erie, and 0.7 foot to the enlargement of the channel into St. Clair River from Lake Huron, by which the steep declivity at this locality has been cut in two. The facts and conclusions in the premises are set forth on pages 37, 83 and 280.

A Trial Examination has been made of the tabulation of volumes and stages of water, 1860-1907, in the Report on the Regulation of Lake Erie by the International Waterways Commission, 1910. No systematic relation of slope to volume is disclosed for St. Clair River. The months of October and November are assumed to represent most nearly all conditions entrain, and the average declivity for these two months compared for similar volumes indicate a material change culminating about 1890. The average for these two months for nine years prior to 1891 gives a fall of 6 feet from Lake Huron to the head of St. Clair Flats Canal, and a volume of

204,455 second-feet, while the average for twelve years subsequent to 1890 gives a fall of 5.32 feet, and a volume of 197,666 second-feet. The difference is 0.68 foot and the volumes are sufficiently close to eliminate material variations due to such cause. The five years of lowest volumes—all since 1890—average 184,880 second-feet and a fall of 5.12 feet.

A Progressive Change in the Port Huron outlet is indicated by the Lake Survey observations of 1908-11, in comparison with the observations of 1899-1901 (Report Chief of Engineers, U. S. A., 1911, p. 3013). ''An increase of about 3 per cent. in the volume of flow through the St. Clair River at mean stage'' is indicated and ''This change is attributed to the effect of recent dredging in the upper river.'' The change of volume is therefore 6,240 cubic feet per second, which corresponds to a change of level of 0.28 foot, or 3.3 inches (see Lake Survey Bulletin No. 21, 1912; also, Topic Nos. 27 and 29). It may be that the change in the Port Huron outlet will continue until the slope is normal with that of St. Clair River below, and such a result would be consistent with the series of physical changes recorded in beach lines, which have occurred since the Port Huron outlet was opened.

An Actual Interference with the levels of the lakes has occurred through obstructions placed in the outlet of Lake Superior at the controlling point of the rapids of the St. Mary's River, by the International Bridge and the Water Power Companies, in 1888, 1892 and 1901, and the effect of such obstructions seems to have escaped notice for a number of years. The subject-matter is discussed at length in the report of the International Waterways Commission for 1910 on the Regulation of Lake Erie (pages 76-81), and it appears that the level of Lake Superior was raised by nearly 1 foot and that by reason of this interference the levels in the lakes below were continuously lower than they would have been, from 1888 to 1905, thus accentuating the extreme low water of 1895, and that the effect amounted to 0.15 foot for Lake Michigan-Huron, 0.12 foot for Lake Erie and 0.10 foot for Lake Ontario. From 1905 to 1907 the effect was reversed by drawing upon the storage of Lake Superior. The International Waterways Commission recommended (1906) that the level of St. Mary's River above the locks be controlled within limits of 1.5 feet, said limits being about 1.35 feet above lowest monthly mean of the navigation season, and about 0.52 foot below the highest monthly mean (Record, 1860-1911). This program has been adopted and the flow of water through the power canals has been restricted when the stage has fallen below the limit. The low water level of Lake Superior has actually been raised by more than 1 foot, and the fluctuations actually controlled within the limit of 1.5 feet, and such rise and control has actually interfered with the flow of water in the St. Mary's River and had its effect upon the lakes below. In view of its recommendations respecting Lake Superior, the following excerpt relating to the lake system, page 10, Report of International Waterways Commission, 1910, is of interest:

> "No work of man has approached or ever will approach this perfection of regulation. The question now is, can he add to that which exists in any important degree?"

26. *Oscillations in Lake Surface* are so variable and continual that changes in lake level are recorded by monthly means rather than by the actual daily and semi-daily observations, as in the case of river stages. These oscillations are due to winds and barometric changes, and are frequently periodic, as seiches, with intervals of minutes or hours, but all diminish after the exciting cause. Such fluctuations sometimes attain a considerable range, they are irregularly persistent and unforeseen, and they are never quite absent.

Lake Currents are due to winds and barometric changes and vary therewith in direction and amount, and there are counter currents in deep water. They are always measurable, sometimes pronounced, and in comparison the movements due to water supply are negligible. No difference in level is discoverable between Lake Michigan and Lake Huron, such as would exist with the water supply in a restricted channel at the Straits of Mackinac, and for physical purposes they are treated as one lake. Strong currents in either direction are found in the Straits, due to winds and to difference in barometric pressure on the two lakes. In the absence of disturbing causes, a water supply of 15,000 second-feet for the Chicago outlet would be drawn from the south thirty per cent. (30%) of the Michigan basin, the other seventy per cent. (70%) setting out by the Straits. The current which would thus be arrested through the cross-section of the lake at the neutral zone would be about one mile per year, a movement utterly undefinable in comparison with the circulation due to winds. The subject-matter for Lake Michigan was investigated by the undersigned for the City of Chicago, in 1886-7, and for Lake Erie about the same time by Walter P. Rice, then City Engineer of Cleveland, and it has since been taken up and reported upon by the U. S. Weather Service.

Changes in Lake Level occur with the seasons, in the years and through a cycle of years, and are primarily due to differences in precipitation and evaporation, and these are conditioned by other meteorological causes, and by soil texture and vegetal cover as affecting amount and rate of run-off. The several Great Lakes are equalizers of the flow in their outlets and thus distribute the effects of water supply and evaporation in streams of more or less uniformity of flow. Changes of level are recorded by monthly means, as noted above, and some of the leading facts are exhibited in the following tabulations:

RECORD, 1860-1911.

Items.	Lake Superior.	Lake Michigan-Huron.	Lake Erie.	Lake Ontario.
Greatest yearly range	2.67 ft. (1869)	1.94 ft. (1876)	2.28 ft. (1892)	3.65 ft. (1867)
Least yearly range	0.49 ft. (1891)	0.59 ft. (1879)	0.87 ft. (1895)	0.79 ft. (1907)
Average yearly range	1.18 ft.	1.21 ft.	1.53 ft.	1.93 ft.
Range in monthly means	3.54 ft.	4.64 ft.	3.89 ft.	5.54 ft.
Range in yearly means	1.42 ft.	3.49 ft.	2.53 ft.	3.34 ft.

The Levels Prior to 1860, so far as known, are recorded in the Report of the U. S. Deep Waterways Commission, 1896. The data for Lake Superior are very meager and need not here be referred to. The lowest known water culminated in 1819-20 from a long and dry period in which the "Great American

Desert'' was depicted on Mitchel's map. At Detroit, which had been occupied since 1702, no tradition existed of a lower level. This low water was frequently referred to until superseded by the high water of 1838—since used as a reference plane—which is the highest known water for Lake Michigan-Huron, and culminated from a period of excessive precipitation, with record floods west of the Alleghenies. These extremes occurred before inhabitation had wrought material changes on the watersheds, and before intermediate channels of the lakes had been disturbed. The range of fluctuation between the low water of 1819-20 and the high water of 1838 was as follows:

Designation,	Range Feet.	Remarks.
L. Michigan-Huron..	6.67	Range for 200 years.
Detroit River	6.67	Range for 200 years.
Lake Erie ... (6.00)	5.75	Higher in 1858 by 0.10 ft. Winter low water may have been lower than 6 ft.
Lake Ontario	5.94	High water same as in 1858. 0.03 ft. higher in 1859, 0.01 ft. higher in 1862, and 0.08 ft. higher in 1870. Lower in 1825-26 by 0.58 ft.

A Second Period, not as uniform, but still characteristic, is embraced by the years 1846-8 to 1858-9, and is tabulated as follows:

Lake Michigan-Huron, Range 4.85 feet, March, 1847, to July, 1859.

Lake Erie, Range 4.57 feet, March, 1846 (data incomplete), to June, 1858.

Lake Ontario, Range 4.78 feet, March, 1846, and November, 1848, to July, 1859.

The high water of 1859 for Lake Michigan-Huron was 0.65 foot below 1838; high water of 1858 for Lake Erie was 0.10 foot above 1838, and the highest known. The high water of 1859 for Lake Ontario was 0.03 foot above 1838 and only exceeded by the high water of 1870, which was 0.08 foot above 1838.

The Third and Last Characteristic Period embraced by the years 1886 to 1895 is tabulated as follows:

Lake Michigan-Huron, Range 4.60 feet, from June, 1886, to December, 1895.

Lake Erie, Range 3.21 feet, from June, 1886, to November, 1895.

Lake Ontario, Range 5.23 feet, from June, 1886, to November, 1895.

The high water of 1886 for Lake Michigan-Huron was 1.09 feet below 1838; for Lake Erie 1.20 feet below, and Lake Ontario 0.23 foot.

The Low Water of 1895, for Lake Michigan, is 0.20 foot below the lowest month of 1847 and 0.98 foot above the low water of 1819; for Lake Erie, 0.06 foot above the low water of 1846 (data incomplete) and 1.59 feet (m. o. l.) above the low water of 1819; for Lake Ontario, 0.71 foot below 1846 and 1848 and 0.48 foot above 1820, and 1.06 feet above 1825 and 1826.

Minor Fluctuations occurred before and after and between the three periods above scheduled, but they are less characteristic for all the lakes and represent meteorological conditions less uniform and extended.

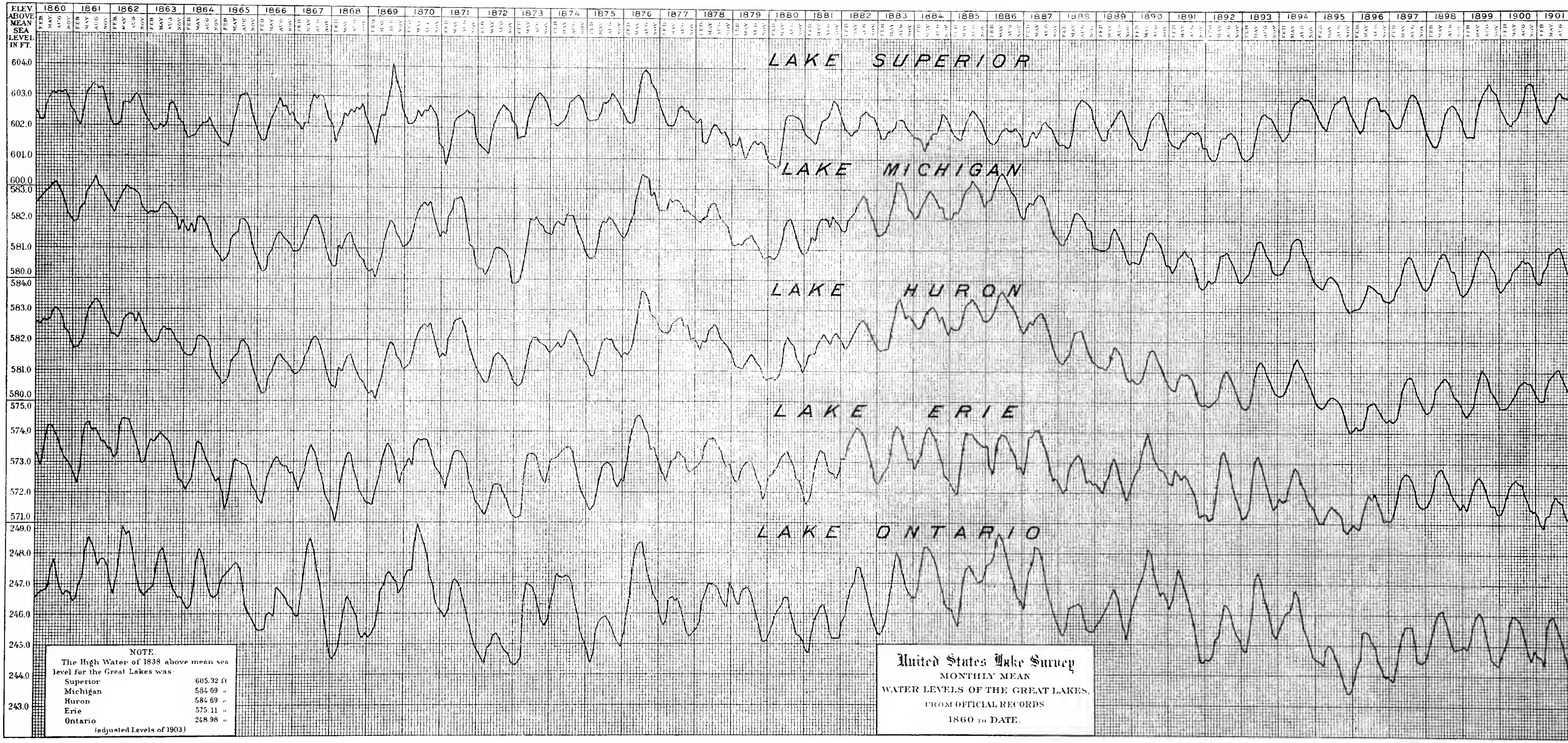
A Lowering of Level is represented by the mean for the period of thirty years, 1860-89, and the mean for twenty-two years, 1890-1911. The difference is shown in the following tabulation:

Lake.	Mean Level. 1860-1889.	1890-1911.	Difference in Feet.
Superior	602.25	602.32	0.07 higher
Michigan-Huron ..	581.84	580.43	1.41
Erie	572.92	572.06	0.86
Ontario	246.58	245.88	0.70

Wind Effects on Lake Erie are discussed at length in a special exhibit in the Report U. S. Deep Waterways Commission, 1896. It appears that between the two ends of the lake easterly gales produce a difference of level of 8 to 12 feet, and westerly gales 12 to 16 feet, in nearly every year, and that differences of 4 to 8 feet are so common as to escape special notice.

The International Waterways Commission, in its report for 1910, page 17, says:

> "It sometimes happens that the stage varies as much as 7 or 8 feet in one day, and more than 2 feet in one hour. Storms raise the water level at Buffalo several feet higher than the normal and lower it at Amherstburg by a like amount; the difference of level between the two ends of the lake in extreme cases being as great as 15 feet."
>
> "*Variations in the level* of the lake's surface, due to winds and to change of barometric pressure, are frequent and irregular and at times violent. Variations of more than six inches are very common, often occurring hourly for many hours in succession, while variations of 2 or 3 feet within an hour are not uncommon. Besides



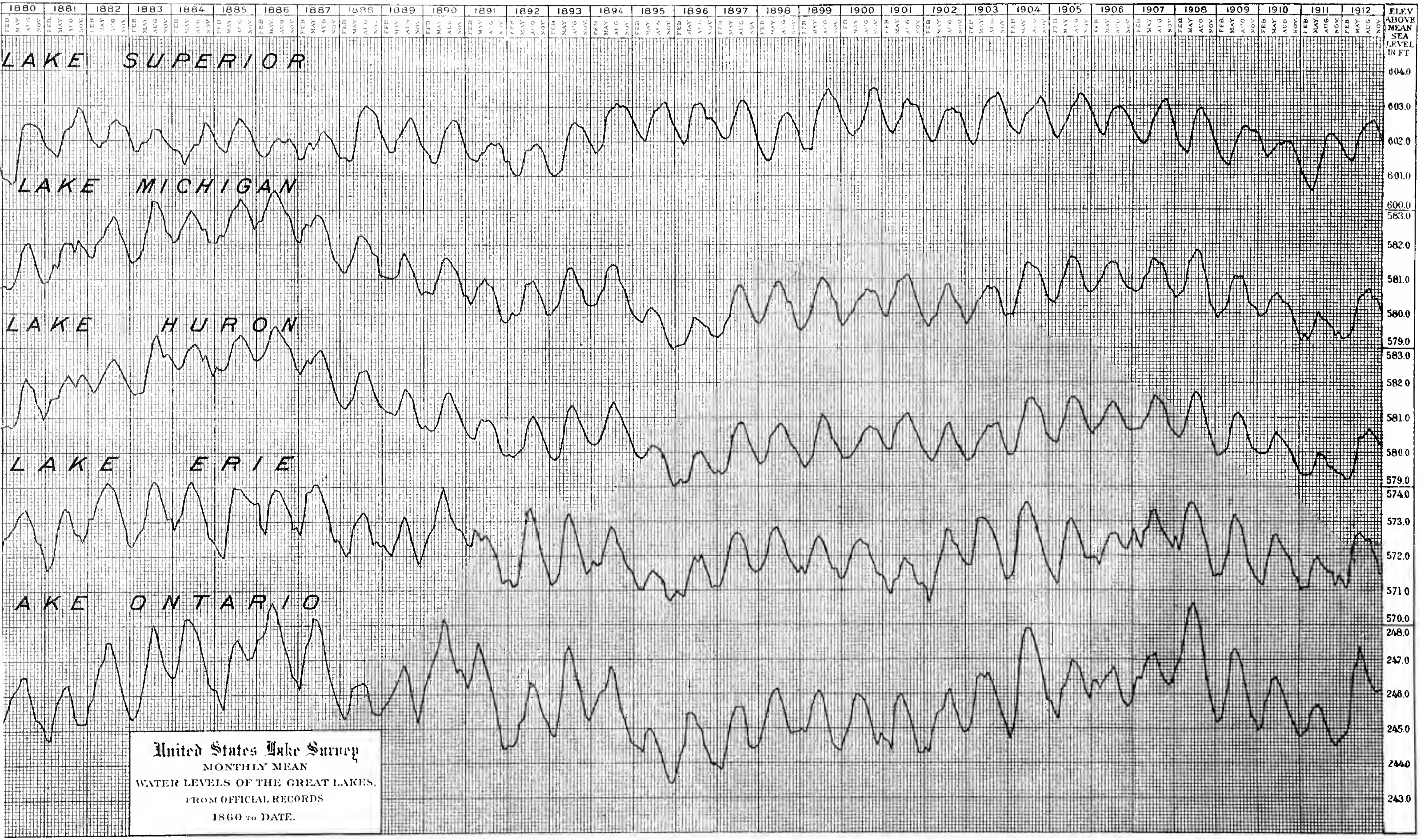
United States Lake Survey
MONTHLY MEAN
WATER LEVELS OF THE GREAT LAKES,
FROM OFFICIAL RECORDS
1860 to DATE.

NOTE.

The High Water of 1838 above mean sea level for the Great Lakes was:

Superior	605.32 ft
Michigan	584.69 "
Huron	584.69 "
Erie	575.11 "
Ontario	248.98 "

(adjusted Levels of 1903)



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> these irregular variations there is a regular annual variation due to difference in rainfall, evaporation, and run-off, the water level being highest in midsummer and lowest in midwinter." "The levels are affected also by the greater or less severity of the winter and the consequent greater or less decrease in the discharging capacity of the outlet by ice."—International Waterways Commission, Report upon the Chicago Drainage Canal, 1907, page 7, and "On Regulation of Lake Erie," 1910, page 11.
>
> "*The Water Surface* has an oscillation varying from a few inches in as many days during calms to about 2 feet per day in variable weather and as much as 6 feet in Lake Superior and 8 feet in Lake Erie during hurricanes, and the monthly mean may change from 0.5 foot to 2 feet per year, or as much as 4 feet during forty years."—Chief of Engineers, U. S. A., 1903, page 532.

The hydrograph hereto attached shows the fluctuations of the several lakes from 1860-1912, inclusive, and is prepared by the U. S. Lake Survey.

27. *The Precipitation Relation* to lake fluctuation has not been comprehensively studied.

The records as far back as 1860 are few in number. These, in part, have been collated for two equal periods of twenty-six years each, 1860-85 and 1886-1911.

The localities are as well distributed as possible, and in some cases a number of fragmentary records have been combined.

The aggregate and the average precipitation for the two periods, and the difference, are shown in the following tabulation:

Place.	1860—1885 Inches. Agg.	Ave.	1886—1911 Inches. Agg.	Ave.	Difference Inches. Agg.	Ave.
Duluth-Superior ...	800.10	30.77	713.10	27.43	87.00	3.34
Marquette	863.50	33.21	838.17	32.24	25.33	0.97
Green Bay Region..	894.11	34.39	769.93	29.61	124.18	4.77
Thunder Bay Region.	953.40	36.67	833.86	32.07	119.54	4.60
Lansing	844.10	32.47	775.36	29.82	68.74	2.65
Chicago	924.62	35.56	808.80	31.10	115.82	4.46
Toledo	918.20	35.31	789.57	30.37	128.63	4.94
Cleveland	977.87	37.61	858.68	33.03	119.19	4.58
Buffalo	991.70	38.14	954.10	36.69	37.60	1.45
Rochester	935.79	35.99	849.85	32.69	85.94	3.30
Oswego	1050.20	40.39	950.02	36.54	100.18	3.85

The precipitation is everywhere lower for the second period, by amounts ranging from 25.33 inches to 128.63 inches, and averaging 92.01 inches (yearly, 3.54 inches); in other words, the deficiency is ten per cent. (10%) more or less for the several stations. It is not assumed that the record here given is the mean for the Lake Basin, but it is sufficiently in accord with the lower lake levels exhibited in Topic 26 and the smaller volumes hereinafter given, for the period of twenty-two years, 1890-1911.

The Outflow Differences between the thirty-year period, 1860-89, and the twenty-two-year period, 1890-1911, together with the differences in stage (Topic 26) and the differences in outflow due to such change in stage, are exhibited below; also, the increment due to 1 foot change in level at mean stage:

Items		L. Superior	Michigan-Huron	Erie	Ontario
Outflow 30-year period, Commission	c.f.s.	85,300	214,300	219,500	266,000
Outflow 22-year period, Commission	c.f.s	75,900	188,250	200,100	235,600
Outflow diff. for the 2 periods	c.f.s.	9,400	26,050	19,400	30,400
Difference in stage	feet	0.07	-1.41	-0.86	-0.70
Diff. in outflow due to stage by Lake Survey increment	c.f.s.	1,100	31,700	18,900	18,900
Diff. in outflow due to stage by Commission increment	c.f.s.	1,300	26,400	20,000	19,700
Lake Survey increment	c.f.s.	15,300	22,500	22,000	27,000
Commission increment (table 23) corrected for mean stage	c.f.s.	18,500	18,700	23,300	28,100

The remarks under the outflow table in Topic 22 also apply.

The increments cover the range from a half-foot below mean stage to a half-foot above same, and are less for lower stages and greater for higher stages. Bulletin No. 21 (1912) of the Lake Survey does not note the variation and this may involve some slight error in the difference of volume due to stage in fifth line of the table. The Commission volumes are taken for the Detroit River and appear to be about two and one-half per cent. (2½%) greater than for the St. Clair River.

Physical Changes have taken place in all the outlets within the period covered by the Commission tabulation.

The effect of these at St. Mary's Falls has been elaborately computed and allowed for.

The Detroit River record was deduced by the Commission on the assumption that no material change had occurred therein, and in order to avoid any change in regimen that may have occurred in the St. Clair River from the enlargement of the outlet at Port Huron (see Topic 25), notwithstanding the fact that the observations were more numerous in the St. Clair River and less subject to the variable effects of back water from Lake Erie.

The Lake Survey observations in the St. Clair River in 1899-1902 and 1908-11 show that the regimen is unsettled.

The effects of the improvements in the Niagara River do not appear to have been valued, and the computations are based on the observations of 1897-1900.

The effects of material changes in the St. Lawrence River at the Galop Rapid, 1881, are not valued in the Commission tables, but the closing of the "Gut Channel" by the Canadian Government, in August, 1903, is accounted for. Lake Survey observations of 1908 and 1911 are designed to value changes at this locality (see Topic 25).

The Discrepancies in the foregoing records, apart from technical treatment, appear to be (see table above and Topics 22 and 25):

(*a*) The average outflow for Lake Superior, deduced from monthly means for the twenty-two year period (1890-1911) is 9,400 feet less than for the thirty-year period (1860-89), while the difference due to stage is 1,300 feet greater, a total of 10,700 feet. Such volume represents a change of stage of 0.57 foot by Commission increment, and 0.70 foot by Lake Survey increment, or the stage for twenty-two years has averaged these amounts above normal level. Again, the average outflow by Commission is 5,300 feet greater than the present average stage outflow by Lake Survey. If this difference is due to the changed conditions for the twenty-three years since 1888, the equivalent is 12,000 feet, representing a difference of stage of 0.65 foot by Commission increment and 0.78 foot by Lake Survey increment. Some such change is due to interferences and artificial control at St. Mary's Falls, and the levels of the lakes below have been admittedly affected.

The Commission increment is twenty-one per cent. (21%) greater than the Lake Survey increment, which indicates that the former capacity, or width, was greater than the present.

(*b*) The average outflow for Lake Michigan-Huron (including Lake St. Clair) in the Detroit River as given by the Commission for fifty-two years is 9,700 feet less than the present mean stage volume by Lake Survey; in other words, the flow at mean stage of Lake Michigan-Huron is now 9,700 feet greater than the average flow for fifty-two years. The equivalent volume for the twenty-two year period is 22,900 feet, corresponding to a change of level of 1.22 feet by Commission increment and 1.02 feet by Lake Survey increment; in other words, for a given volume, the average stage for twenty-two years is so much lower through the enlargement of the Port Huron outlet, occurring in or about 1886-9 and still in progress by last Lake Survey report. Again, the period difference (1860-89 and 1890-1911) by record of monthly means is 26,050 feet, which practically agrees with the difference due to stage, 26,400 feet, and this is not consistent with a change in outlet conditions.

The Lake Survey increment exceeds the Commission increment by twenty per cent. (20%), and this indicates greater present capacity or width of outlet.

(*c*) The average outflow for Lake Erie by Commission record is 800 feet less than the mean stage determination of the Lake Survey. No radical discrepancy is disclosed by the difference in volume from the record of monthly means for the thirty and twenty-two-year periods, and the difference due to stage. The Commission increment is some six per cent. (6%) greater than the Lake Survey increment. Slight lowering and slight constriction of outlet are indicated and such results are consistent with improved channels partly compensated in the Niagara River.

(*d*) The data as compiled for Lake Erie do not indicate any considerable change in level due to outlet conditions during the period covered by the investigation, 1860-1911.

The data as compiled for Lake Michigan-Huron in comparison with Lake Erie do indicate a material change in outlet conditions. The differences in volume for the two periods (1860-89 and 1890-1911) from the record of monthly means and by difference of stage, range from 26,050 to 31,700 feet, and exceed those for Lake Erie by 6,650 feet for the monthly mean record, by 6,400 feet for the Commission increment and by 12,800 feet for the Lake Survey increment.

Under like relative conditions the difference in the two periods for Lake Erie should be greater rather than less. The apparent excess is due to a false stage; in other words, the level of Lake Michigan-Huron has been lowered.

(*e*) The average outflow for Lake Ontario by Commission record of monthly means is 10,300 feet (0.38 foot in stage) greater than the mean stage determination of the Lake Survey for the present conditions. If the difference be due to error in taking the volume for twenty-one years on the basis of the enlarged channel made in 1881 in the Galop Rapid, that change approximated 1 foot in level. The difference in volume from the record of monthly means between the thirty and twenty-two-year periods is 30,400 feet, while the difference due to stage is 19,700 feet; in other words, the difference in volume corresponds to 1.09 feet in stage, while the actual difference in stage is 0.70 foot. This also indicates unvalued change in outlet conditions (see Topic 25). The mean discharge of the St. Lawrence River at the Galops (see Topic 22) is probably in excess by 10,300 second feet (m. o. l.).

The Foregoing Analysis is indicative, but the data do not appear to lend themselves to close determination. The Commission tabulations seem not to have valued all the changes in some of the outlets, and revised determinations are suggested by the later Lake Survey observations, and also the need of observations covering a greater range in stage. The later observations denote changes in outlet capacity and further changes will follow work in progress and yet to be undertaken. The investigations thus far made and the results obtained are to be regarded as tentative.

28. *The Effect of a Diversion* of 10,000 cubic feet of water per second upon the levels of the several Great Lakes was considered in 1885 when the Chicago Sanitary and Ship Canal was projected by the undersigned.

The subject-matter was discussed in a brief by L. E. Cooley, C. E., on the Lakes and Gulf Waterway, appendix No. 8, published by the Citizens' Association of Chicago, January, 1888, and the same was incorporated in a series of papers read before the Western Society of Engineers, September 5, 1888, and at subsequent dates, by G. Y. Wisner, L. E. Cooley, L. M. Haupt, Clemens Herschel, J. B. Johnson, Wm. Pierson Judson, Walter P. Rice, D. Farrand Henry and Benezette Williams, under the general title, "Levels of the Lakes as Affected by the Proposed Lake Michigan and Mississippi Waterway."

This collection of papers was published in the journal of the Association of Engineering Societies, March, 1889, and at the same time reprinted with supplemental matter, for distribution at large by the Citizens' Association of Chicago, under the general title, "The Levels of the Lakes as Affected by the Proposed Lakes and Gulf Waterway."

These papers appeared and were distributed prior to the passage of the Sanitary District Act, approved May 29, 1889, in force July 1, 1889.

These discussions exhaustively considered the available data (largely the Lake Charts and reports of Lake Survey, Chief of Engineers, U. S. A., 1868-69-70 and 82) and recognized that such data was incompetent to a specific determination.

The effect was variously estimated at 2½ to 5 inches, but owing to oscillations and fluctuations, a change of level from such cause could not be determined by direct observation and would not be material in its effect upon navigation.

"*Lake Level Effects* on Account of the Sanitary Canal of Chicago," dated November 27, 1894, is a brief by L. E. Cooley, C. E., then a Trustee of the Sanitary District of Chicago, prepared for and at the request of Harvey D. Goulder, attorney of the Lake Carriers' Association, and was accompanied by a map and other matter.

This was printed in the Proceedings of the Board of Trustees of the Sanitary District of Chicago July 2, 1895, pp. 2698-2706; also, Proceedings International Deep Waterways Association, Cleveland, September, 1895, pp. 361-368.

The subject-matter is reviewed and additional measurements in the Niagara River in 1891-2, Report of Chief of Engineers, U. S. A., 1893, are referred to, but otherwise the available data are the same as in the discussion of 1888-9, above referred to.

The probable effect is placed between the limits 0.2 foot and 0.4 foot (2.4 inches and 4.8 inches), but a specific determination requires a systematic measurement of the outflow with respect to stage in the several outlets. Stress is laid upon the need of deeper channels and ample clearance beneath the boat, and the effect of diversion under the varying condition of lake surface is not regarded as important.

If the contrary view is held, however, a remedy can be cheaply applied and should content the objectors in view of the great benefits.

A technical discussion by Thomas T. Johnston, Assistant Chief Engineer, is also printed in the Proceedings, July 2, 1895, pp. 2706-22, and reprinted in the Proceedings of the Cleveland Convention, September, 1895, pp. 368-383. Mr. Johnston concludes that the effect of diverting 10,000 cubic feet will be less than half a foot, and that the data are unsatisfactory.

A Board of Engineers, Colonel O. M. Poe, Major E. H. Ruffner and Major W. L. Marshal, was appointed by the Secretary of War in 1895, on petition of the Cleveland Chamber of Commerce and other commercial bodies about the Great Lakes, including the Chicago Board of Trade, for the purpose of reporting upon "the probable effect of the operation of the Chicago Drainage Canal upon the lake and harbor levels and their connecting waterways" (Proceedings of Board of Trustees, May 24, 1895, p. 2653). The Board of Trustees of the Sanitary District submits the several documents above referred to and other related matter, and by its Engineering Committee observes, "It appears from the evidence that the effects will be small, but that an absolute demonstration is impossible in the present state of information. We may add further that comprehensive measurements of the outflow of the several lakes under all conditions and extended through a term of years are evidently very desirable, for many public reasons" (Proceedings Board of Trustees, July 2, 1895, p. 2697 *et seq.*). The Board of Engineers inspected the canal, then well advanced in construction, and its report is printed in the Proceedings of the International Deep Waterways Association, Cleveland, September, 1895, pp. 358-60. It appears the observations of 1891-2 in the Niagara River were suggested to the Chief of Engineers, U. S. A., by the Engineer of the Montreal Harbor Commission through the secretary of the American Society of Civil Engineers. These observations are not clearly indicative, as pointed out in literature contemporary with their publication, in Mr. Johnston's paper and in this report, and they are cautiously referred to as the basis for a possible lowering of Lake Erie by 0.53 foot and of Lake Michigan-Huron by 0.61 foot. The Board characterizes all prior data as incompetent, thus agreeing with all prior investigators. The Board suggests accurate and comprehensive measurements at all stages and sufficient to eliminate accidental variations, and that such observations only will determine final results. The Board also deprecates the good faith of professional men who considered the matter prior to its time.

The International Waterways Commission, appointed in 1895, the American section of which was known as the United States Deep Waterways Commission, was charged with the duty of determining the feasibility of extending ocean navigation into the Great Lakes, "with an adequate and controllable supply of water for continual use," and it reported in 1896. It collected and digested all available information respecting the elevations and fluctuations in level of the several Great Lakes and connecting channels, the areas of the basins, and the effect of gales on Lake Erie. It specifically recommended a comprehensive series of discharge measurements continued for several years so as to cover the range of fluctuation, the compilation of precipitation records, and the collection of all data bearing upon the physical phenomena of the Lake System; also special studies to determine the feasibility of controlling the level of Lake Erie.

The Board of Engineers on Deep Waterways was appointed in 1897 to carry out the recommendations of the Commission and reported in 1900. It limited its duties largely to surveys, projects and estimates of routes and control of the level of Lake Erie, and in such connection undertook measurements of the outflow of the Niagara River, in 1897, which, together with measurements made by the Lake Survey, in 1898, are printed in the report.

A systematic series of measurements in the several outlets was undertaken and carried out by the U. S. Lake Survey in 1898-1902, under the project for the resurvey of the Northern and Northwestern Lakes, and these are published in the Reports of the Chief of Engineers, U. S. A. It will be noted that these measurements were not undertaken until ten years after the need for them was publicly expressed and that the first series was not completed until ten years after the work on the Chicago Sanitary Canal actually began, and about two years after the channel was actually opened.

The series of measurements of 1898-1902 has been supplemented by measurements made in 1908 and since, to cover a greater range in stage and changes in conditions.

The International Waterways Commission (the second) was authorized by Congress and appointed in 1902, but the Commission did not organize until after the Canadian section thereof was appointed, some two years later. Its duties were limited to questions relating to the control of the waters of the Great Lakes, and it was charged with an investigation of the control of the level of Lake Erie and the effect of the diversion of waters from their natural outlet. This is the first Act of Congress that can be specifically applied to the Chicago diversion.

The subject-matter was reported upon in January, 1907, "Chicago Drainage Canal." The Commission reports on Regulation of Lake Erie, 1910. and this is valuable in the same connection. The Lake Survey gives later valuations of the outflow of the lakes in the Report of the Chief of Engineers, 1910, and brings the subject-matter down to date in bulletin No. 21, 1912.

29. *Lower Mean Lake Levels* will obtain by reason of the diversion of water at Chicago, and are estimated by the International Waterways Commission as follows (Chicago Drainage Canal, 1907, pp. 7 and 9):

	Water Level Lowered by diversion at Chicago of	
	10,000 c. f. s.	14,000 c. f. s.
Location.	Foot.	Foot.
Lake Michigan-Huron	0.52	0.70
Lake St. Clair..................	0.45	0.64
Lake Erie	0.45	0.64
Lake Ontario	0.35	0.49
St. Lawrence River at Rapide Plat	0.40	0.56
St. Lawrence River at Head of Cornwall Canal	0.40	0.56

The mean level referred to is that for forty-six years, 1860-1905. Elaborate investigations by the Lake Survey are referred to (Report of Chief of Engineers, U. S. A., 1900, 1902 and 1904). The need of further observations is recognized, but the belief is expressed that the foregoing determinations are reliable within one-tenth of a foot. It is stated, also, that the effect will be greater at lower stages and less at higher stages, but the variation is not given. (The results on page 76, Regulation of Lake Erie, 1910, seem to be in error, in part, and are therefore omitted.)

The Increment of Volume for a change of 1 foot in level at mean stage for forty-eight years, 1860-1907, is given by the International Waterways Commission in its Report on the Regulation of Lake Erie, 1910, p. 53; also, the increment for stages above and below the mean. The increment for a change of 1 foot in level at mean stage for fifty-two years, 1860-1911, is given in Lake Survey Bulletin No. 21, for 1912. The Commission Increment, corrected for the mean level of fifty-two years, and the Lake Survey Increment, are given below:

Lakes.	Mean Elevation. 52 years.	Commission Increment c. f. s.	Lake Survey Increment c. f. s.
Superior	602.28	18,500	15,300
Michigan-Huron	581.25	18,700	22,500
Erie	572.56	23,300	22,000
Ontario	246.18	28,100	27,000

The foregoing increments cover the range from one-half foot below mean stage to one-half foot above mean stage.

The Changes in Level by the two increments for volumes of 10,000 feet and 14,000 feet diverted at Chicago, are as follows:

Cub. Ft. Per Sec.	Authority.	Michigan-Huron.	Erie.	Ontario.
		Ft.	Ft.	Ft.
10,000	Commission	0.53	0.43	0.35
10,000	Lake Survey	0.44	0.45	0.37
14,000	Commission	0.75	0.60	0.50
14,000	Lake Survey	0.62	0.64	0.52

The differences in the Commission figures given in the report of 1907 and as deduced from the increments given in the report of 1910, for Lake Michigan-Huron and Lake Erie, are due in part to the differences in mean stage.

The Commission figures as above deduced are less than the Lake Survey figures for Lake Ontario and Lake Erie by a small amount, while they exceed the Lake Survey figures for Lake Michigan-Huron by about twenty per cent. (20%). The latest official determination of the effect of diverting 10,000 feet is therefore 5.3 inches for Lake Michigan-Huron, 5.4 inches for Lake Erie and 4.4 inches for Lake Ontario, and the caution of the Commission in stating its figures has not been amiss.

Taking the average flow at Chicago for twelve years at 4,800 cubic feet per second, the effect on Lake Michigan-Huron has been 2.56 inches by the last determination. These figures may again change with observations covering a larger range in stage and through further improvement in channels. *Dis-*

crepancies in official determinations from official scientific data evidences the elusive nature of the problem. It is quite amazing that such determinations differ so little from the limits fixed nearly twenty-five years ago by professional men from the consideration of data largely official which was officially discredited.

30. *The Yearly Loss* occasioned by six inches less depth in channels and harbors, by reason of the diversion of water at Chicago, is estimated by the International Waterways Commission at $1,500,000 in round numbers. (Report on Chicago Drainage Canal, p. 8.) This estimate is stated to be conservative and that it will increase with the growth of commerce. ''Advantage is taken of any temporary increase of stage,'' is stated in the report. The report predicates a like loss at any and all stages.

Normal Increase of Stage or seasonal changes is probably meant by the language ''temporary increase of stage,'' as the temporary changes, hereinbefore referred to (Topic 26) seldom survive the time of a trip and could not be availed of. The minimum stage is habitually referred to in official reports as the measure of the available depth for navigation and as the plane of reference for improvements, almost without qualification. It is not strange, therefore, if some should have erred, if error it be, in assuming a change in the low water depth to be the measure of damage. Higher stages may be, and are, availed of but does it follow that the diminution in the high stages are as injurious as in the low stages? If the lake should return to the level of 1838 would there not be a strenuous demand for some means to reduce the heights without objection from the Lake Carriers' Association? The Commission itself deprecates the higher stages in discussing "Regulation."

The Estimate is Excessive or is not even justified, for the following reasons:

(*a*) Loaded drafts cannot anticipate and do not discriminate to the nicety above referred to.

(*b*) The actual lowering is less and has not been finally determined.

(*c*) The injury is not constant for all stages.

(*d*) The deepening of channels has been and is to be progressive, and the increase in depth has been many times the effect of loss from diversion and will be many times the effect of future diversion.

(*e*) Clearance beneath the boat is recognized as important and its precise value cannot be closely estimated. The International Navigation Congress which convened in Philadelphia May 23, 1912, adopted the following declaration:

> "In a maritime canal a wet section five times as large as the immersed portion of the largest ship which is to use the canal is desirable, as also a depth of one meter under the keel; but these values are functions of the speed at which the canal is to be navigated and therefore to some extent also of the volume of commerce, and are to be determined by local conditions."

The Measure of Damage is estimated in the report (pages 8-9) as the cost of deepening channels and harbors by one foot and the cost of lowering the upper and lower entrance of all the Canadian canals, and in round numbers is as follows:

Intermediate Channels	$5,000,000
Harbors, U. S. and Canada	5,000,000
Canadian Canals	2,500,000
Total	$12,500,000

The report deprecates the inconvenience due to this deepening and the time required to execute the same, and that such submerged channels are not so efficient, and that new harbor developments will be prejudiced.

The Foregoing Estimate is for an increase of depth by one foot and is therefore for a volume of 22,500 feet at Chicago by the latest determination of the Lake Survey; in other words, the work scheduled will make possible the diversion of 22,500 cubic feet of water per second without damage to lake interests. As existing projects in process of execution call for larger depths in channel ways and harbors, and as still further depths are predicated by the Davis Lock, the additional depth of one foot produced in connection with the projects will cost much less and not be a source of extra inconvenience. Again, the depths on the sills of the upper and lower entrance locks of the several Canadian canals at standard low water differ by more than two feet, as Exhibited in Topic 23 (see also Report United States Deep Waterways Commission, 1896), and a commensurate depth throughout does not require the uniform change covered by the estimate, and it is therefore excessive.

31. *Remedies for the Damage* occasioned by the diversion of water at Chicago are discussed in official reports.

(*a*) The International Waterways Commission reports adversely on the proposition to control the outflow of Lake Superior in such manner as to ameliorate the extremes of fluctuation in the lakes below, or equalize the stages in some degree so as to mitigate low water to the extent of the effect of the diversion (see early discussions referred to in Topic 28). The subject matter is discussed at length on pages 22 and 73-81, Report, Regulation of Lake Erie, 1910. Reference is made to "the use of Lake Superior as a reservoir, which has been proposed by persons not familiar with the Great Lakes, to compensate for the diversion of water through the Chicago Drainage Canal." If anyone has proposed to change the mean levels of the lakes below, by controlling the outflow of Lake Superior, the discussion is understandable. This is quite a different proposition from such redistribution of flow as will benefit the levels of the lakes below. The adverse and unpremeditated control of outflow has prejudiced the levels below by 1.8 inches for Lake Michigan-Huron, 1.44 inches for Lake Erie and 1.2 inches for Lake Ontario (page 81 *ibid*) or by about 2/3 of the effect assigned to the present outflow of the Chicago Drainage Canal. The report (page 83 *ibid*) refers to the beneficial natural control exercised by ice on the channels between Lake Huron and Lake Erie. It is therefore not quite clear why Lake Superior as a reservoir cannot be controlled beneficially as well as adversely, and why it should differ from other reservoirs in use for the control of stream level below. As other and adequate remedies are officially suggested, however, no issue need now be taken with the conclusion.

(*b*) The U. S. Board of Engineers on Deep Waterways (report of 1900) elaborates a project for the control of Lake Erie at a level some three feet above low water, the effect of which will be to raise the level of Lake Michigan-Huron by about one foot, thus incidentally remedying the effect of the diversion at Chicago. The Report of the International Waterways Commission of 1910 is largely devoted to a review of this project, and its opinion is adverse to so radical a regulation, and admits the feasibility of a minor control, but recommends against the same. One foot control of Lake Erie is stated to raise the level of Lake St. Clair by 0.61 foot, and the level of Lake Michigan-Huron by 0.27 foot, and the advantage of so much control is recognized, but an adverse effect of several inches is found for Lake Ontario and the Saint Lawrence River.

(*c*) Projects for the regulation of Lake Michigan-Huron, by works in the St. Clair River, and for the regulation of Lake Ontario, by works in the Saint Lawrence River, at the Galop Rapids, are commented upon adversely.

(*d*) The Commission defines "Regulation Works" as those designed to control the fluctuation of the Lakes within narrow limits rather than a popular term covering all forms of control. Regulation in this sense interferes with the reservoir action of the Lakes, which should be increased and added to rather than diminished. The Commission does, however, commend works of control that do not interfere with natural reservoir action, under the designation of "Compensating Works." The report states (page 21 *ibid*): "If the level of any lake has been lowered, whether by diversion through the Chicago Drainage Canal or by enlargment of the outlet, the remedy seems to lie in 'Compensating' rather than in 'regulating' works." Again, (pages 20-21 *ibid*): "It is possible to raise the level of any lake by simply reducing the size of the outlet * * * but the oscillations will go on as before, and the discharge will remain the same. To raise the level of Lake Erie will raise also, but to a less degree, the levels of Lake St. Clair and of Michigan-Huron, and will thus benefit those waters, while it will have no effect upon Lake Ontario or the St. Lawrence River." This method was favored by the late General O. M. Poe (deceased autumn, 1895) in connection with improved channels and the water-power canals at St. Mary's Falls.

Special surveys of the Niagara River have been made and the Commission expects to close its labors with a supplemental report on "Compensating Work."

Deeper Channels as a remedy are discussed by the Commission in its report on the Chicago Drainage Canal, 1907 (page 9), and it is shown that all channels and harbors affected may be deepened one foot at a cost of $12,500,000 in round numbers. In the preceding topics (Nos. 29 and 30) it is shown that such deepening will provide for a diversion of 22,500 second feet at Chicago and that the cost thereof may be much less.

Further Consideration of the subject-matter is called for by the Act of Congress, approved June 25, 1910, by a "Special Board of Engineers upon a waterway from Lockport, Ill., by way of the Des

Plaines and Illinois Rivers, to the mouth of said Illinois River, and certain related subjects,'' in the following language: ''Said board shall report upon * * * such measures as may be required to properly preserve the levels of the Great Lakes and to compensate, so far as practicable, for the diminished level in said lakes and the connecting waters thereof by reason of any diversion of water from Lake Michigan for the maintenance of the proposed waterway herein described, or diversion for any other purpose; * * * and further, also, as to the effect upon the climate of the Lake states by a change in the natural currents of Lake Michigan.'' The report was to be submitted to Congress not later than the first Monday in December, 1910, but the same has not been submitted up to this writing.

Two Official Remedies are reported feasible. The one by compensating work is favored but has not been finally reported upon. The other by deepening channels and harbors one foot, thus providing for a diversion of 22,500 feet, is qualified. Remedies are also to be recommended by the special Board, and its report is over-due.

32. *The Population about the Great Lakes,* above Niagara and outside the Urban District of Chicago in Illinois and Indiana (2,376,758), in communities of 2,500 and upwards, U. S. census, 1910, and Canadian census, 1911, is as follows:

	United States.		Canada.			
Division.	No.	Pop'n.	No.	Pop'n.	No.	Total.
Lake Superior	11	183,120	3	38,703	14	221,823
Lake Michigan-Huron .	35	828,372	8	41,199	43	869,571
Bet. L. Huron & L. Erie	8	511,189	5	37,075	13	548,264
L. Erie and Niagara R.	19	1,453,652	4	18,043	23	1,471,695
	73	2,976,333	20	135,020	93	3,111,353

The Urban Population on Lake Ontario and the Saint Lawrence River to the International Boundary Line and the Galop Rapids below Prescott, is as follows:

United States .... (Including Rochester.)	4 cities	260,401
Canada	13 cities	527,062
Total	17 cities	787,463

The Urban Population along the Saint Lawrence River from the Galop Rapids and the International Boundary Line, to and including Quebec, all in Canada, represents eleven (11) cities with a population of 606,772, of which 106,513 are on actual tide water.

The Total Urban Population about the Great Lakes, omitting the Chicago District, and along the Saint Lawrence River, in the United States and Canada, is 4,505,588. Such population is reinforced by tributary population to a very limited extent in comparison with a water route between the Lakes and the Gulf of Mexico. The Lake Superior population (221,823) and the tide water population (106,513), aggregating 328,336, is not affected by the Chicago diversion.

33. *The Expenditures on Waterways* by the United States from the beginning to June 30, 1911, are given in Senate Document, No. 382, 62nd Congress, 2nd Session. The total is $627,098,236.05. Of this amount $45,012,165.68 is for "Examinations, Operation, Surveys, etc." (p. 26) not specified, thus leaving $582,086,070.37 which can be assigned.

The Expenditures for the Great Lakes have been $106,205,935.64 or some eighteen per cent (18%) of the assignable total. This sum is distributed as follows:

Surveys:		$3,392,394.45
Lake Survey	$2,907,850.14	
Atlantic Waterways	484,544.31	
Lake Outlets:		32,460,681.19
St. Mary's R. & Canal	17,607,923.26	
St. Clair & Detroit R.	10,713,417.90	
Connecting Channels	3,340,000.00	
Niagara River	731,340.03	
St. Lawrence River	68,000.00	
Lake Michigan:		24,574,422.11
Chicago	3,994,620.11	
Calumet	2,538,720.44	
Milwaukee	2,309,766.90	
Sturgeon Bay Canal	594,241.13	
34 other ports	15,137,073.53	
Lake Superior:		10,427,608.63
Duluth-Superior	6,105,115.94	
Portage Lake and Canal	1,706,357.79	
8 other ports	2,616,134.90	
Lake Huron and Outlet to L. Erie:		3,500,137.81
Harbor Beach	1,948,798.24	
12 other ports	1,551,339.57	
Lake Erie and Niagara River:		26,565,312.78
Buffalo	8,431,201.17	
Cleveland	6,659,618.31	
Toledo	2,576,500.00	
13 other ports	8,898,993,30	
Lake Ontario and St. Lawrence River:		5,285,381.67
Oswego	2,292,437.07	
14 other ports	2,992,974.60	
Total, given above		$106,205,935.04

The foregoing tabulation does not include expenditures made by states, municipalities and other corporations, and these data have not been compiled.

The Urban District of Chicago, in Illinois and northwestern Indiana, covers the two ports, Chicago and Calumet, the latter being in two states and including Indiana Harbor. The Federal expenditure for this district is represented by the sum of the two items, and is $6,533,340.55. This sum is about six per cent. (6%) of the total for the Great Lakes. It is exceeded by Buffalo and by Cleveland, and nearly equalled by Duluth-Superior, and Milwaukee, Toledo and Oswego are each nearly forty per cent. (40%) of the same.

The Canadian Expenditures on Canals and River improvements up to March 31, 1911, is given in the annual reports for 1911, of the Department of Railways and Canals and the Department of Marine and Fisheries, Dominion of Canada. An abstract of the expenditures pertaining to the Great Lakes and St. Lawrence is given below:

	Original Prior to Confederation, 1867.	Enlargement or Since Confederation.	Total.
Sault Ste. Marie Canals		$4,923,329.97	$4,923,329.97
Welland Canal	$7,693,824.03	21,049,468.96	28,743,292.99
L. Ontario, North Channel & Murray Canals		2,967,725.54	2,967,725.54
St. Lawrence River & Canals below Prescott	7,485,680.08	33,854,251.76	41,339,931.84
	$15,179,504.11	$62,794,776.23	$77,974,280.34

The St. Lawrence Ship Channel below Montreal, $12,115,102.64.

Items 2 and 4 include in the original expenditures prior to confederation $262,220 by Imperial Government, and also small amounts since the confederation of 1867.

The Total Expenditure upon works now under the control of the Dominion Government has been $90,089,382.98; in addition thereto expenditures have been made for Harbor improvements by local Harbor boards and municipalities.

A Comparison of Expenditures by the two governments should omit the Saint Lawrence below Prescott and Ogdensburg, the same being an outlet to the sea to be compared to the expenditures by the State of New York, and by other states in opening communication with the sea. In making such comparison the relative population will be of interest as set forth in Topics No. 2, No. 20 and No. 32.

Any Damage from Diversion applies only to the upper and lower entrance of the several canals, and the lack of uniformity in such depths has already been referred to in Topic No. 23 and No. 30.

PART II.

The Argument.

D. THE ILLINOIS BIRTHRIGHT.

34. *The Illinois Route* was first traversed in September, 1673, by Joliet and Marquette on their return from the Mississippi River to Green Bay. Father Claude Dablon, Father Superior, of the Jesuit Missions, Quebec, August 1, 1674, reports:

> "The fourth remark concerns a very great and important advantage, which perhaps will hardly be believed. It is that we could go with facility to Florida in a bark, and by very easy navigation. It would be necessary to make a canal, by cutting through but half a league of prairie, to pass from the foot of the Lake of the Illinois (Lake Michigan) to the River Saint Louis (Desplaines). Here is the route that would be followed: The bark would be built on Lake Erie, which is near Lake Ontario; it would easily pass from Lake Erie to Lake Huron, whence it would enter Lake Illinois. At the end of that lake the canal or excavation of which I have spoken would be made, to gain a passage into the river Saint Louis, which falls into the Mississippi. The bark, when there, would easily sail to the Gulf of Mexico." (Jesuit Relations, Vol. 58, p. 105, Thwaite translation.)

Father Marquette wintered at Chicago, in 1674-5, on the West Fork of the South Branch of the Chicago River, opposite the head of the present Drainage Canal. Flood-waters, coming across the portage from the Desplaines River, drove him from his cabin on March 29, 1675, and on March 31st, he crossed the portage in his boats on his way to the

Illinois country, but illness soon compelled his return and he died on the east shore of Lake Michigan, south of the Saint Joseph River.

The Griffin, the first vessel to sail the upper Great Lakes, was built by LaSalle on the shores of the Niagara River and made a trip to Green Bay in 1679, but was lost on the return. LaSalle established Fort Miami at the mouth of the Saint Joseph River, the only harbor at the south end of the lake which could then accommodate the Griffin, and proceeded thence by way of the Saint Joseph River, the portage near South Bend, Indiana, and the Kankakee River, to the Illinois country, arriving at Lake Peoria, January 1, 1680. He established Fort Creve Coeur, and undertook the building of a suitable vessel by which to descend the Illinois and Mississippi Rivers. His resources were inadequate and, after sending Father Hennepin to explore the Upper Mississippi, March 2, 1680, he returned. The Griffin is described as a bark of forty-five tons burthen, and the Peoria vessel was to be a bark of forty tons burthen, but dimensions are not stated. A length of about seventy feet, a beam of about sixteen feet, and a draught of three feet or less, old models, would satisfy the description. LaSalle rendezvoused his party in Chicago, January 4, 1682, proceeded over the ice on sleighs, found open water at Lake Peoria, and launching his boats reached the margin of the Gulf of Mexico, April 9, 1682. He returned to the head of the alluvial division of the Illinois River, 1½ miles above the present Utica bridge, and there on the south shore established Fort St. Louis in December, 1682. He remained here until the Autumn of 1683, then returned to France and fitted out an expedition to open up the Mississippi River from the sea, but he missed the mouth, landed in Texas and was assassinated March 19, 1687. The site of Fort St. Louis was the scene of the virtual extermination of the Illini tribes in 1770, by the northern Indians in revenge for the assassination of Pontiac, and has since been known as "Starved Rock," and is now included in the State Park established by the General Assembly of Illinois, in 1911.

"*Fort Chicagou*, where M. de la Durantaye commanded," 1685 is mentioned in memoir by Tonty, commandant at Fort St. Louis. The two forts were about 100 miles apart by the water-trail which was continuous at high-water and broken by portages at low-water. One was accessible when not closed by ice, from a great lake system, and the other was accessible from a great river system and little inconvenienced by ice. The two posts seem to have been depots for the trade of the lakes and of the rivers, and passage made between the same when conditions favored. The route is the subject of frequent mention in early narratives and reports and is depicted on early maps, and it came to be recognized as one of the three principal routes "for trade and travel" between the Lake Region and the Mississippi River system, and the special route to the Illinois country and between Mackinaw and the American settlements along the Mississippi River from Cahokia to Kaskaskia. The route continued in use in the fur trade until the Black Hawk war of 1830-3, and the final removal of the Indians from

Illinois in 1836. An elaborate article descriptive of the route and its possibilities appeared in the St. Louis Enquirer, in April, 1819, of which the following is an excerpt:

> "The communication between the lake and the Illinois is a point which will fix the attention of the merchant and the statesman. They will see in it the gate which is to open the northern seas into the valley of the Mississippi, and which is to connect New York and New Orleans by a water line, which the combined navies of the world cannot cut off. Never did the work of nature require so little from the hand of art to complete so great a design. * * * The French of Canada, and of the valley of the Mississippi, have communicated through this channel since the settlement of the countries. In high water boats of ten or a dozen tons pass without obstruction. In the dry season, they are unloaded, placed on vehicles, and drawn by oxen over a portage of a few miles, and launched into the river or lake, as the course of the voyage may require. Hundreds, nay thousands, of boats have been seen at St. Louis which have made a similar passage. * * * It may be hoped that the government will not limit itself to the barren work of marking the lines about this portage. While the State of New York opens a canal of 300 miles, the federal government should not be appalled at undertaking one of 300 rods. It might be dug in the time that a long-winded member of Congress would make a speech against its constitutionality."

The authorship of this article is acknowledged by no less a man than Thomas H. Benton, in a letter dated June 20, 1847, to the Niles Register, Vol. 22, 5th Series.

35. *Early Official Recognition* is given the Illinois route. The Ordinance of Virginia, July 13, 1787, accepting the cession of the Northwest Territory, provided as follows:

> "The navigable waters leading into the Mississippi and the St. Lawrence, and the carrying places between the same, shall be common highways, and forever free, as well to the inhabitants of the said territory as to the citizens of the United States, and those of any other state that may be admitted into the Confederacy, without any tax, impost, or duty therefor."

The Greenville Treaty, August 3, 1795, recognizes free passage through the Illinois route and cedes "One piece of land six miles square at mouth of Chicago River * * * where a fort formerly stood; one piece twelve miles square at or near the mouth of the Illinois; one piece six miles square at the Old Peorian fort and village, near south end of the Illinois Lake (Lake Peoria) on the said Illinois River."

The Pottawatamie Treaty, August 24, 1816, extinguished the Indian title in the territory of Illinois, south of the parallel touching the south end of Lake Michigan, which had been partly extinguished by the treaty of November 3, 1804, with the Sacs and Foxes. It ceded further a strip of land within ten miles of the Water route, and out to what is since known as the "Indian boundary line," extending from Lake Michigan to the Fox River on the north, and from Lake Michigan to the Kankakee River on the south, then largely in the territory of Wisconsin. The Indian title north of the parallel was finally extinguished, by treaties in 1830, 1832 and 1833, and the Indians were placed on western reservations in 1836.

The Practicability of Improving the route is covered by two early reports transmitted by John C. Calhoun, Secretary of War, to Henry Clay, Speaker of the House of Representatives, U. S., 28th of December, 1819.

The Report of Major Stephen H. Long is dated March 4, 1817, and contains the following:

> "In the flat prairie, above mentioned, is a small lake, about five miles in length, and from six to thirty or forty yards in width, communicating both with the River Desplaines, and Chicago River, by means of a kind of canal, which has been made partly by the current of the water, and partly by the French and Indians, for the purpose of getting their boats across in that direction, in time of high water. The distance from the River Desplaines to Chicago River, by this water course, is about nine miles; through the greater part of which, there is more or less water, so that portage is seldom more than three miles in the driest season; but in a wet season, boats pass and repass with facility between the two rivers."

Major LONG states further:

> "The water course, which is already opened between the River Desplaines and Chicago River, needs but little more excavation to render it sufficiently capacious for all the purposes of a canal."

The Report of Graham & Phillips, is dated April 4, 1819. It seems that R. Graham, Joseph Phillips and Surveyor Sullivan, were sent out to define the "Indian boundary line" and the parallel touching the south end of Lake Michigan, and they reported also on the practicability of improved navigation between the Illinois River and Lake Michigan. They describe the physical conditions between the Desplaines and Chicago Rivers and conclude as follows:

> "The route by the *Chicago,* as followed by the French since the discovery of the Illinois, presents at one season of the year an uninterrupted water communication for boats of six or eight tons burthen, between the Mississippi and the Michigan Lake; at another season, a portage of two miles; at another, a portage of seven miles, from the bend of the Plein to the arm of the Lake; at another a portage of fifty miles, from the mouth of the Plein to the Lake; over which there is a well beaten wagon road, and boats and their loads are hauled by oxen and vehicles kept for that purpose by the French settlers at the Chicago."

Thomas H. Benton acknowledges his personal contact with the members of this party as his inspiration for the article in the St. Louis Enquirer. (Topic 34.)

The Land Surveys of 1821, subdivided the lands within the "Indian boundary lines." The Desplaines River was meandered up to the township line at Lyons, where the fifty-mile road mentioned by Graham and Phillips crosses the river, and this point was entered in the note book of the Surveyor, John Walls, as "Head of Navigation." The Chicago River was also meandered up to the Forks, at Bridgeport, about 7½ miles east of the Desplaines River. The note books and the plats mention and delineate such features as: "portage slough," "portage swamp," "portage lake," and "portage road."

Official Reference to the route is also made in the report of Albert Gallatin on Means of Internal Communication in 1808, where it was given a prominent place; it was included in a bill in Congress in 1811, along with Erie and other canals, and it was recommended in a message by President Madison in 1814. Clinton and Morris of the State of New York, 1808-25, advocate it as an extension of the commerce of the Erie Canal to the Mississippi River.

36. *The State of Illinois* was admitted to the Federal union in 1818. The territorial boundary between Illinois and Wisconsin, as fixed by the Ordinance of 1787, was the parallel touching the southerly bend of Lake Michigan. The boundary for the new state was shifted northward sixty-one miles, nineteen chains and thirteen links, to latitude 42 deg. 30 min., thus adding 8,500 square miles from the Territory of Wisconsin. The purpose was to give the new state a water front on the Great Lakes and the Port of Chicago, and to place the water route within the confines of a single state. Nathaniel Pope, the Territorial Delegate, argued that the southern portion of the state was the nucleus of a great river system, and that the northern end of the state should have a like relation to the Great Lake system and with adequate supporting ground, and that the state would thus become a bond of commercial union between the basin of the Saint Lawrence and the basin of the Mississippi, and forever insure the perpetuation of the Confederacy. (Ford's History of Illinois, p. 20-3; Blanchard's History of Chicago, p. 493-5.)

Northern Illinois, when the state was admitted in 1818, contained only Indians and a few fur traders, there being no actual settlement nor settlers north of the latitude of Springfield, Chicago having but two white families. By the early thirties, Peoria, Princeton, Dixon and Galena had been founded, largely by northern emigration coming over the mountains of Pennsylvania and Virginia, and by the rivers, Ohio, Mississippi and Illinois, shipping their effects, in some cases, by sea and by way of New Orleans. Congress appropriated for opening the mouth of the Chicago River in 1833, and in the spring of 1834 the cut across the bar was opened by a flood coming largely across the portage from the Desplaines River, and a lake vessel entered the harbor for the first time. At this time Chicago had "twenty hamlets." Emigration through the new port increased rapidly after the Black Hawk War and the removal of the Indians in 1836, and by 1840 Chicago had a population of 4,479. A balance between population of southern and northern origin soon obtained, and thus was realized a prime purpose in changing the boundary of the new state.

The Constitutional Right of the General Government to improve and develop waterways was not generally recognized during the first decades of the Union and when Illinois was admitted as a state in 1818. The right to build canals, except for military purposes, was questioned as late as 1890 when the Illinois and Mississippi (Hennepin) Canal was appropriated for, and even after work began on the Chicago Drainage Canal, in 1892. The early views held that the Federal function did not pertain to the physical highway, but related to the commerce thereon between the states and foreign nations, and was similar to the duties since exercised respecting commerce over our railway system. The Federal interest in waterways manifested itself in grants of land to the states, much as it did later in land grants to railways. Congress had, therefore, a specific purpose in so fixing the boundaries of the new state as to bring the great water route under one sovereignty, and Illinois was thus endowed with a special privilege and charged with a particular duty; made, in fact, a trustee for all the people.

The Growing Opinion, later, favored the improvement of natural easements and the canals incident thereto, and River and Harbor bills became features of Congressional legislation in the thirties. The issues involved culminated in the veto by President Polk, in 1846, to which Daniel Webster expressed vigorous dissent in his Philadelphia speech, December 2, 1846. The first National Harbors and Rivers Convention was called in protest at Chicago, and held July 5, 1847, and its proceedings contained two letters from Mr. Webster, dated June 26, 1847. Mr. Webster practically determined the right and duty of the Federal Government. Interpretations in time drifted to the opposite extreme until the Federal jurisdiction was assumed to be exclusive and to be exercised affirmatively, rather than paramount and to be exercised negatively. Latterly, there is developing the doctrine of co-operation between Federal and State agencies, and such doctrine must be given the broadest and most liberal construction, if a waterway system is to be produced. Paramount and affirmative Federal jurisdiction thus become largely that of co-ordination and supplement, and of work beyond the province of states, while the negative jurisdiction follows early interpretations and the practice relating to our railway system.

37. *The Illinois and Michigan Canal Project,* like the Erie Canal of New York, was mobilized by the War of 1812, and there followed the Indian Boundary Treaty of 1816, Long's examination and report, in 1816-17, the accommodation of the new state boundary, in 1818, and the report of Phillips and Graham in 1819 (see Topic 35). The northern half of Illinois had only a nominal population and little taxable value until after the final removal of the Indians in 1836, local incentive was lacking and the resources of the new state were inadequate to so great an undertaking. Nevertheless, early documents and records are eloquent respecting the duties of the state and the broad and far-reaching character of the enterprise.

Congress granted a right of way through the public lands by Act of March 30, 1822, the State acted in 1823, made the Post and Paul survey in 1823-4, and filed plans in 1825. Congress made a grant of land, five alternate sections on each side of the route and amounting to 284,000 acres, by Act of March 2, 1827, and passed supplemental legislation in 1833, 1842 and 1854. The State awaited Federal surveys, made in 1829-30, but the estimate of Gen. Gratiot, Chief Engineer, for a steamboat canal, 100 feet wide and ten feet deep, was not submitted until 1834. Meantime the State made the Bucklin survey in 1830-1 and the report of 1833. Canal construction had been authorized in 1829, but plans were not settled and final legislation had until January, 1836. Construction actually began at the head of the canal at Bridgeport, July 4, 1836.

The Canal, as located and constructed, left the

Chicago River at the Forks, 5.4 miles from Lake Michigan, extended across the Portage Swamp region to the Desplaines Valley, thence skirted the southeasterly margin of the Valley to Joliet, thence along the northerly margin to La Salle, a distance of 97.24 miles, and descended 146.6 feet from low water of Lake Michigan (Chicago datum) to low water of the Illinois River. The water supply was from the Lake by way of the Chicago River, the summit level having a declivity of one-tenth foot per mile for twenty-nine miles to Lockport. The prism had a depth of six feet, a surface width of sixty feet and a bottom width of thirty-six feet in earth and forty-eight feet in rock. The locks had a length of 110 feet between quoins, a width of eighteen feet and a depth of six feet. The canal had fifteen lift-locks and one guard-lock.

The work proceeded diligently until resources were exhausted in 1841, in consequence of the financial panic of 1837. The state property was placed in the hands of trustees for the bond holders in 1843, and work resumed on a modified plan in 1845, the summit level for 26.5 miles being fixed temporarily at eight feet above datum and fed from the Desplaines River, the Calumet River and by a lift-wheel from the Chicago River. The canal was actually opened to traffic in the spring of 1848. The first boat to pass through the canal reached Chicago April 23, 1848, and carried a shipment of sugar from New Orleans to New York. The summit level was cut out on the original plan in 1866-71. The total cost, including the cutting down of the summit level, was $9,513,021.50, interest, maintenance and operation not included (see Topic 10 for Sanitary History).

The Operation of the Canal was a success from the beginning. The State resumed direct control in 1871 (Act of April 22), a unique example of a public utility out of debt and it still shows a surplus. In 1885, Canal Commissioner Brainerd reported that it had saved the people within reach of its influence not less than $180,000,000.

A Cession of the Canal to the United States was made by an Act approved by vote of the people November 5, 1882, "for the purpose of making and maintaining an enlarged canal and waterway from Lake Michigan to the Illinois and Mississippi Rivers," the grant to be accepted within five years. The enlargement of the Canal was reported upon as an extension of the Hennepin project to the Chicago River. (Report Chief of Engineers, U. S. A., 1883, p. 1761.) The bill covering this project failed to pass Congress in 1886, and a Board of Army Engineers, known as the Comstock Board, reviewed the subject matter, and reported that the river between Joliet and La Salle could be improved at less cost. (Report of Chief of Engineers, U. S. A., 1887, p. 2125.) The grant lapsed November 5, 1887. Following this report and by Act of May 31, 1887, the locks and dams at Henry and Copperas Creek, built from surplus canal revenue, were ceded to the United States on condition that a through waterway be built between Lake Michigan and the Mississippi River. This Act was repealed and the conditions of cession changed and limited to four years by an act in force July 1, 1889 (see Topic 13). This cession has also lapsed. The State expended on these works $747,747.51.

The Pope Annex developed rapidly after the opening of the Chicago River, in 1834, the beginning of canal construction, in 1836, and the passing of the Indian title to lands by the treaties of 1830, 1832 and 1833, and the removal of the Indians in 1836. The village of Chicago was organized August 10, 1833, with a total poll of twenty-eight votes. The population of Chicago and environs reached about 28,000 when the canal was opened, in 1848, and this had nearly doubled when the first railway, the Michigan Southern, reached town in 1852. The Galena Union railway had been opened from Chicago to Elgin in 1848, and by 1855 several trunk lines had been added. The growth was amazing, and forty years after the canal was opened the population exceeded one million. The waterway opportunity, belated and inadequate as was its development, gave Chicago the lead over its rivals by a generation, and made her the nucleus and the cross-roads of the growing system of land transportation until she became the metropolis of the continental interior.

38. *The Joliet Ship Canal Project* of 1674, changed by time and circumstance, has persisted through all the years. It found official expression in the report of General Gratiot in 1834, a precedent which could well have been followed and expanded upon in the later reports of the War Department. In the absence of adequate co-operation by the United States, the Illinois and Michigan Canal was fully commensurate with the resources of its time, but not a decade passed without renewed efforts for a better interpretation of the physical opportunity. Some of these efforts were partial and had the incidental purpose of increasing the useful radius of the Canal during the low water season of the Illinois River. Captain Howard Stansbury made an examination of the Lower Illinois River in 1838, and Congress made a single appropriation for dredging in 1852, the good effects of which were noted fifteen years later. The State undertook the improvement of the Lower Illinois River by locks and dams (Act of February 28, 1867), with locks 350 feet long between quoins, seventy-five feet wide and seven feet deep, and opened the work at Henry in 1871, and followed with the work at Copperas Creek in 1877, and the United States completed the project by the work at La Grange, opened in 1889, and the work at Kampsville, opened in 1893 (see Topics 13 and 14). The general project has been the subject of examination and report as follows:

(*a*) 1857-8, by John B. Preston. Extensive surveys and steamboat project, urged in Congress as a war measure in 1862; also, by Chicago Waterway Convention, representing fourteen states, June 2, 1863, as part of a project from the Mississippi River to the Atlantic seaboard.

(*b*) 1866-7, under authority of Congress, by Gen. J. H. Wilson, Instructions of Department for "the solution of the question of an adequate supply of water from Lake Michigan as a reservoir for the canal and river during periods of low water." Preliminary report states that this is the only route feasible for the largest steamboats, suggests a canal 160 feet wide, Chicago to Lockport, and the improvement of the river by locks and dams, the locks 350 feet long between quoins, seventy-five feet wide and seven feet deep, and recommends final surveys under government auspices. It appears that this report is largely based on the data of the late John B. Preston, turned over on request, by Governor Oglesby, acting for the State. (Ex. Doc. 16, 40th Cong., 1st Sess.)

(*c*) 1867-8, under authority of Congress, by a Board, consisting of Gen. J. H. Wilson and Wm. Gooding, civil engineer, who constructed the Illinois and Michigan Canal. Extended surveys and a project "adapted to military, naval and commercial purposes." Water supply from Lake Michigan for improvement of the Lower Illinois River, too costly. Lock dimensions as above given. (Report Chief of Engineers, U. S. A., 1868.)

(*d*) 1874-5, under authority of Congress, by Col. J. N. Macomb. Resurvey from Hennepin to Chicago as part of "Northern Transportation Route." Project and estimate with locks of dimensions as above given. (Report Chief of Engineers, U. S. A., 1875.)

(*e*) 1882-4, under authority of Congress, by Major W. H. H. Benyaurd. Survey, project and estimate between Joliet and La Salle, with locks as above. Compared with examination of 1882 for enlarged canal. (Report Chief of Engineers, U. S. A., 1884.)

(*f*) 1886-7, under authority of Congress, by Board of Army Engineers, known as Comstock Board. Review of project of Hennepin Canal and extension to Chicago. Favors river between Joliet and La Salle.

(Report of Chief of Engineers, U. S. A., 1887, and Ex. Doc. No. 79 H. R., 49th Cong., 2nd Sess.)

The River Location between Joliet and La Salle is favored in all the foregoing reports, together with a canal 160 feet wide between the Chicago River and Lockport, and the projects repeat the lock dimensions adopted for the State work at Henry.

The Definition of State Policy in 1889 has been followed by five reports for a larger scale of navigation, the last of which is not final. (See Topic 17.)

The Expenditure by the United States for surveys and improvements between the Chicago River and the Mississippi River, by way of the Illinois River, up to June 30, 1911, has been, $2,325,597.73. (S. Doc. 382, 62nd Cong., 2nd Sess.)

39. *The Site of Chicago,* in itself, was a sanitary problem, and so recognized and acted upon as soon as the city's growth seemed assured. Mr. E. S. Chesbrough, authority on drainage and water supply, and City Engineer for twenty-five years, 1854-79, wisely directed the formative period. Before his retirement, he stated to the undersigned that the ship-canal solution was ideal, and would become practicable if the city reached a million inhabittants. In 1881, while the undersigned was in the federal service at St. Louis, the reservoir problem at headwaters of the Mississippi River was under consideration, and he made a special study, from all available data, of the use of the Illinois water route in connection with the great natural reservoirs of the upper Great Lakes.

The August Rain of 1885 (August 2nd), the greatest of record, precipitated the radical solution which had been tentatively recognized and academically considered for some years. A committee of the Citizens' Association assembled the pertinent facts, and its report of August 27, 1885, drawn by the undersigned, outlined the project since carried out. The original draught justified the prediction of one million inhabitants in 1890, but this paragraph was stricken out by the full committee on the ground that it would discredit the report, as no one believed that such a population would be reached—the members of the committee themselves did not believe it. Official consideration was vigorously promoted and action by the City Council followed, January 27th and February 23, 1886.

The Drainage and Water Supply Commission was appointed, expended some $65,000, made a preliminary report January 30, 1887, but was disbanded by the new Administration, November 5, 1887, before its final report had been digested. Popular scientific ideas and the prejudices of the Administration led the Commission to apply its resources largely to artificial methods of sewage disposal. Three propositions were worked out and compared on a population basis of 2,500,000 to be attained between 1905 and 1915, all as set forth in Topic 21.

The Findings of the Commission were along evolutionary lines and in favor of the dilution method by means of a ship canal across the Chicago Divide, such canal to have sufficient capacity to divert all floodwater, including the sewage, from Lake Michigan.

The Hurd Bill expressed the views of the Commission, but the General Assembly of 1887 regarded the subject-matter as unripe, and appointed a joint committee to report to the next General Assembly. Authority was granted for the Desplaines and North Branch diversion, but has never been availed of.

The Joint Committee (Mayor of Chicago, Ex-Officio, Chairman, and the City footing bills) reviewed the subject-matter, utilized the later investigations of the State Board of Health, made researches on its own account, and held a number of hearings. It reported its findings in the draught of a bill February 1, 1889, and the same as amended became the Sanitary District Act, in force July 1, 1889.. (See Topics 3 and 12.) The hereditary waterway policy asserted itself in this Act, and was reinforced by other legislation, and has been confirmed and expanded in all subsequent legislation. (See Topics 13, 14, 15 and 16.)

The Legal Principles underlying the law, were the subject of a special conference by eight of the most eminent counsel in the State of Illinois. No question was ever raised or doubt expressed as to the right of the State of Illinois to authorize the enterprise and appropriate the waters needed to qualify the same.

40. *Diligent Progress* from "shovel-day," September 3, 1892, to "the opening," January 17, 1900, was the spirit of work on the Chicago Drainage Canal. At the close of the first Board of Trustees, December 2, 1895, three-fourths of the excavation on the Main Channel was reported as completed. All claims under contracts had been adjusted, and a uniform date stipulated for completion. The auxiliary work in the Chicago River and in the vicinity of Joliet and legal complications attending the same, financial stringency and unprovided resources, and the delays incident to public bodies dealing with unusual problems, deferred the expected opening for some two years. Nevertheless, the work for magnitude, character, method and time, was one of the great achievements. (See Topics 4, 5, 6 and 7.)

Radical Improvement in Methods, only, made it possible for Chicago to finance the undertaking. Channeling machines, cantilever hoists and cableways, were used on such work for the first time and the price of rock excavation cut in two; hydraulic dredging was practically developed; new methods of earth spoiling were applied, and earth excavators greatly improved; and there were also negative lessons. The state of the art showed greater development than for the preceding twenty years, greater than has since occurred.

The Renown of the Work was wide-spread. The World's Columbian Exposition brought thousands of visitors and special trains were run while active work continued. The public press heralded it from the house-tops and the technical press of the world described and illustrated it. Attaches of legations and other agents inspected the work from time to time and reported officially to foreign governments. It was inspected by the Canadian members of the first International Waterways Commission, by the Nicaragua Canal Commission, by a Board of Army Engineers in 1895, and by the Chief of Engineers, U. S. A., Gen. John M. Wilson, in 1899. The work was studied on the ground by Gen. T. C. Catchings, Chairman of the Rivers and Harbors Committee, and by numbers of other Congressmen.

No Official Objection was made by any Executive Department of the General Government, and the subject-matter was not discussed on the floor of either branch of the Congress. There were not the usual proportion of adverse critics and objectors, and these were largely home products.

41. "*State of Missouri* against State of Illinois and the Sanitary District of Chicago," is a suit in equity in the Supreme Court of the United States, to restrain the discharge of "undeficated and unpurified" sewage of Chicago through an artificial channel into the Desplaines River. The original bill of complaint was filed January 17, 1900, and the demurrer thereto overruled (U. S. Rpt., Vol. 180, p. 208), the court holding that a continuing nuisance could be enjoined at any time and that the complainant was entitled to relief if an explicit case could be made out, and ordered the issue to trial on its merits. Systematic "biologic and chemic" examinations of the stream between Chicago and St. Louis, before and after the opening of the Drainage Canal, and of other streams, special examinations and observations and expert evidence respecting every phase of sewage pollution and disposal, were introduced in evidence. The history of the project, the practice of other cities on the stream system above St. Louis and alternative methods of disposal were fully set forth. Particular stress was laid upon the point that Chicago had no natural right to dispose of its sewage in an alien watershed. Six years were taken in preparing and presenting the case, during which time the waters of Lake Michigan with the sewage of Chicago, were arguing their own right of way. The court dismissed the bill without prejudice February 19, 1906; opinion by Holmes. (U. S. Repts., Vol. 200, p. 518.)

The Cause of Action has been attributed to the adverse waterway attitude of a section of the Chicago press and the reactionary course of the second Board of Trustees, thus alienating influences at St. Louis which had co-operated in the original program, and giving the right of way to the hostiles. Be that as it may, things often happen better than they can be planned.

The Opinion of the Court discusses the principles involved in issues of this character and reviews the evidence at length and concludes that no case justifying action has been made out. Some pertinent points are here referred to:

(*a*) States have rights superior to individuals.

(*b*) An injunction will not issue when the injury resulting therefrom will exceed the damage complained of.

(*c*) Complainant's position is prejudiced by reason of the fact that he is a contributor to the conditions complained of and is following methods identical with those alleged against the defendant.

(*d*) Proof of nuisance should be direct and explicit rather than inference from subtle analyses by experts.

(*e*) Chicago is acting under proper and sufficient authority. On this point the court says:

> "Some stress was laid on the proposition that Chicago is not in the natural watershed of the Mississippi, because of a rise of a few feet between the Desplaines and the Chicago Rivers. We perceive no reason for a distinction on this ground. The natural features relied upon are of the smallest. And if under any circumstances they could affect the case, it is enough to say that Illinois brought Chicago into the Mississippi watershed, in pursuance not only of its own statutes, but also of the Acts of Congress of March 30, 1822, c. 14, 3 St. 659, and March 2, 1827, c. 51, 4 St. 234, the validity of which is not disputed. *Wisconsin* v. *Duluth*, 96 U. S. 379. Of course these Acts do not grant the right to discharge sewage, but the case stands no differently in point of law from a suit because of the discharge from Peoria into the Illinois, or from any other or all the other cities on the banks of that stream."

Res Adjudicata expresses the legal status of the Illinois and Michigan Canal and the Chicago Drainage Canal, and the disposal of sewage therein, subject only to the limitations of natural streams. It will be observed that a new stream or outlet has been established on the footing of a natural stream by authority of the State of Illinois, and also by authority of the United States, granted eighty to ninety years ago. It may be said further that the new State of Illinois was endowed with the purpose by Congress in 1818, and that the physical opportunity is a resource of the people of the Illinois country, recognized from the discovery and dedicated by the project of Joliet in 1674.

The Actual Appropriation of Water is determined by the dimensions and capacity of the channels or carriers. This is the immemorial rule in regions where all waters are dedicated to beneficial use, subject only to priority and the limitations of time and volume mentioned in the claim or filing. The same rule, but not so well defined, applies in humid countries to the extent to which waters are put to beneficial use, and will obtain fuller recognition as beneficial uses multiply. The fact that channels are not now used to their full capacity is no more pertinent than would be the case in an irrigation ditch before the lands under the same are developed. There are no limitations of time in the authority for the Chicago Drainage Canal other than certain developments parallel with works of the United States, but nevertheless work proceeded diligently, and the appropriation of waters was quickly expressed in physical enactments on the ground. There was no limitation of volume except by minimums, defined arbitrarily in part and in part by sanitary conditions and progressive increase with growth of population. The interpretation of what was a reasonable investment provision, is also entered upon the ground.

The Rights Established are:

First. The Chicago Drainage Canal and the Illinois and Michigan Canal are established on the basis of natural streams or outlets by proper and sufficient authority.

Second. The disposal of sewage in such channels is on the same footing as on natural streams.

Third. The waters appropriated are determined by the actual physical capacity of the channels, to-wit: Chicago Drainage Canal, 14,000 cubic feet per second as estimated at standard low water of Lake Michigan; Illinois and Michigan Canal, 1,000 cubic feet per second and as much more as the channel is capable of carrying.

Fourth. The taking of the water is determined by its application to beneficial use, as sanitation, waterway and water power.

42. *The Secretary of War* is delegated by Congress with certain powers respecting the conservation of the navigable waters of the United States, expressed in the Act of March 3, 1899, and supplemented by the Act of June 13, 1902, the same being in part an expansion and codification of prior enactments. In some quarters, it is presumed that this legislation authorizes an interference with the diversion of water by way of the Chicago Drainage Canal.

(*a*) Such an interpretation is not justified by the opinion of the Supreme Court of the United States in the case of The State of Missouri against the State of Illinois and the Sanitary District of Chicago. (See Topic 41.)

(*b*) The rights of states are superior to those of natural and artificial persons to whom the legislation particularly applies. The right of a state is plenary when paramount jurisdiction for purposes of improvement has not been taken by specific act of Congress. That such paramount jurisdiction extended to the physical highway was denied or questioned during the first half of our constitutional history. (See Topic 36.)

(*c*) The Federal Permit of May 8, 1899, given pursuant to Section 10 of the Act of March 3, 1899, does not relate to the diversion of water, but does relate solely to the Chicago River, paramount jurisdiction over which was taken by Congress by the Act of June, 3, 1896. The Secretary of War has not, therefore, assumed a broader interpretation, and the principle applied is similar to that expressed in Section 17 of the Sanitary District Act. The necessity for the permit has been questioned in view of belated federal jurisdiction and it seems to have been accepted as a gratuity. (Topic No. 8.)

No Interference with the diversion of water by way of the Chicago Drainage Canal was intended by the Congress in the Act of March 3, 1899.

(*a*) The Proceedings of the Board of Trustees of the Sanitary District of Chicago, December 21 and 28, 1898 (pp. 5355 and 5377), record two measures which were referred to the proper committee and its report was submitted January 11, 1899 (p. 5421), and the Board thereupon adopted an address to Governor Tanner praying for the appointment of a special commission to inspect and certify the completion of the Main Channel as provided by Section 27 of the Sanitary District Act, in order that the opening of said channel shall not be delayed, and reciting "the completion of the Main Drainage Channel" and that "The auxiliary work in the Chicago River and in the Desplaines at Joliet is nearing completion." The Act of March 3, 1899, is not only after the beginning of work, but after the substantial completion thereof.

(*b*) The Trustees of the Sanitary District were unaware of any pending legislation that could affect their enterprise, nor were they aware of any hearings respecting the subject-matter. The public press contained no intimation of legislation of such import.

(*c*) The Illinois delegation in Congress and its members of the Rivers and Harbors Committee would have protested most vigorously against legislation adverse to the Illinois work, nor would the chairman of that committee, the Honorable Theodore E. Burton, have consented to an act with a surreptitious meaning; in fact and at a later time, the undersigned discussed with the chairman the lapses which forbade restrictive legislation. (See Topic 40.)

(*d*) Informal acquiescense expresses the attitude of cities and states of the Mississippi Valley and lake region and of official circles in the United States and Canada. This is recognized in sundry paragraphs of the report of the International Waterways Commission on the Chicago Drainage Canal, 1907, and the following is quoted (p. 14):

> "The diversion of large bodies of water from Lake Michigan for supplying the drainage canal has not been authorized by Congress, but there appears to be a tacit general agreement that no objection will be made to the diversion of 10,000 cubic feet per second, as originally planned."

Strictly speaking, the text should read "*authorized or prohibited*" for "authorized" and "14,000 cubic feet" for "10,000 cubic feet." (See Topic 7.)

The Rights are authoritatively and sufficiently established. If the judicial branch will not enjoin when injuries exceeding the damages complained of are thereby occasioned, then adverse action is not competent to the executive and legislative branches of the government. Accomplished facts are not to be set aside, but the unrighteous enjoyment of rights may impair the estate. Consideration is thus invited to the alleged wrongs.

E. NO MATERIAL EFFECT FROM CHICAGO DIVERSION.

43. *The Levels of the Several Great Lakes,* from a variety of causes, change continually through limits measured by inches and by feet. Causes are so diverse and so complexly conditioned and are so incapable of fore-valuation, that the order, time and measure of phenomena can only be forecasted in the most general way, if at all.

The segregation of a minor cause and the determination of its effect is perplexing and uncertain. Such cause, unknown in character and amount, would not disclose itself or even be suspected, in the records of years.

Official reports indicate little attempt to determine the effect of channel improvements and other changes in outlet conditions, and such results as have been given are inferences from "subtle expert analyses" after the causative facts are known rather than direct proof by observation. The findings, therefore, are in the nature of hypotheses at best mere probabilities, and being incapable of direct proof or verification by actual observation, they fail under the second rule of evidence.

The Record exhibits average and aggregate effects of prior causes. Lake levels are known and compared by monthly means which mask local or temporary effects. From the Niagara River discharge measurements, 1897-8, seventy-two in number, twenty-eight were eliminated as too erratic for expert analysis in the determination of the discharge formula. (Rpt., Board of Engineers on Deep Waterways, 1900, p. 318-19.) Such illustrations caution against attaching to conclusions greater certainties than pertain to the underlying data, even though reinforced by tedious and painstaking computations, mysterious and complex formulae and awe-inspiring tabulations. The farmer cannot tell what it will cost per bushel to raise his next crop of wheat and may not be quite certain after he has harvested and marketed the same; the railway expert cannot figure out the cost of the individual shipment, and no man has charted the individual movements of the bees in a swarm. The trend and the tendency of the aggregate may be exhibited, but the multiplicity of elements are not distinctly separable by reason of the nature of the problem and the insufficiency of the data respecting the same.

Observations, scientific and by the latest methods, to determine the discharge in the several outlets, were undertaken in 1898, as a part of the resurvey of the lakes, and the first series was completed in 1902. A second series to cover a greater range in stage and value outlet changes, was begun in 1908 and has already led to revised determinations of outflow. It will be noted that the first series began some six years after the inauguration of work on the Chicago Drainage Canal and about the time of its substantial completion (see Topic 42), and was not completed until nearly three years after the opening of the Channel; and further, that new observations with revised determinations are still in progress, ten years later. Congress did not call for a report upon the subject-matter until the Act of 1902 (see Topic 28), two years after the opening, and then for the consideration of any necessary remedial measures rather than for an indictment. It will be noted, further, that the probabilities indicated by the official investigation (see Topic 29), do not differ so greatly from the results of the unofficial studies (see Topic 28) made prior to and during the construction of the Chicago Drainage Canal, that the interested public can be said to have been misinformed upon the subject-matter.

The Official Determination of the effect of diverting 10,000 cubic feet of water per second at Chicago, as deduced from the increment for one foot change of level at mean stage, is given below. (See Topic 29.)

Authority—	L. Mich.-Huron. (Ins.)	Lake Erie. (Ins.)	Lake Ont. (Ins.)
Rept. Int. Com., 1910..........	6.36	5.16	4.20
Lake Sur. Bull. No. 21, 1912....	5.28	5.40	4.44

The estimate of the International Commission in the report of 1907 is practically the same. The effect of a diversion of 4,800 cubic feet, the average for twelve years, is estimated at 2.56 inches for Lake Michigan-Huron by Lake Survey increment.

It will be noted that the Commission estimate for

Lake Michigan-Huron exceeds the last determination by Lake Survey increment by more than twenty-one per cent. (21%). The latest surveys indicate enlargement still in progress at the Port Huron outlet (see Topic 25), so other values may be substituted later. The elusive nature of the problem may be inferred from the exhibits hereinbefore made. (See Topic 27.) The importance of any such change is indicated by its relative value among other changes, artificial and natural, some of which are referred to later.

No Material Effect is a conclusion based on the following considerations:

(*a*) The degree of effect is an inference from "subtle expert analyses" and not capable of proof by direct observation. (See Topic 41, Missouri case.)

(*b*) The effect is a part of and contributory to much greater changes that have not been thought worthy of correction.

(*c*) The interested public was fully advised respecting the probabilities prior to and during the construction of the Chicago Drainage Canal and no protest was made.

(*d*) No competent official observations or deductions therefrom were made until after the opening of the channel, and such observations and deductions are still in progress. Information only has been asked for by Congress and subsequent to the opening of the Channel.

(*e*) A damage known only to the proprietor through expert information not comprehensible to the potential claimant, is doubtful.

(*f*) A margin of depth beneath the vessel, several times the alleged effect, is recognized as sound practice and is dictated by prudence on account of unforseen fluctuations. (See Topic 30.)

(*g*) The actual physical effect is relatively small in the family of changes from natural and artificial causes. (See Topics 44 and 45.)

(*i*) The damages, as officially estimated, are small in comparison to benefits and such estimates are excessive. (See Topic 30.)

(*l*) Channel and harbor deepening during and since the construction of the Drainage Canal and still in progress, and greater depths already predicated by the Davis lock, many times exceed the alleged effect. A complaint based on a condition not before enjoyed, is doubtful. (See Topics 23 and 24.)

(*j*) Remedies are readily applied and are competent to the alleged effect, and remedial works are necessary to the fuller and better development of channels and harbors. (See Topic 44.)

(*k*) The effect is subordinate to and masked by major effects and the remedy is incidental to and included in the betterment of channels and the control of levels.

44. *The Horizon of Lake Fluctuation,* otherwise referred to as "general level" or "mean level," changes with outlet conditions. An increase or decrease of the outflow raises or lowers the level, and the level is also raised or lowered by a contraction or enlargement of the outlet. A canal taking water independent of the outlet is a diversion which is as effective on the level of an individual lake as though the canal led into another basin. An improvement of the outlet channel, thereby increasing its capacity, will reduce the level of the lake above as effectively as a diversion of water. Outlet changes with estimated effects, so far as compiled, are referred to as follows:

The St. Mary's River had an original low water depth of about eight feet and is now increased to 21-2 feet in a much shorter channel. The declivity has been reduced to 1.57 feet, or to one-half that contemporaneous with the Poe lock, and a further reduction will follow channels four feet deeper and commensurate with the Davis lock. Water power canals with an aggregate capacity greater than the Chicago Drainage Canal, have been constructed around the falls on the Canadian and American shores and compensation works placed at the head of the rapids. These works were so operated between 1888 and 1905 as to make Lake Superior in effect a private mill pond, and the level admittedly raised by about one foot with consequent lowering of Lake Michigan-Huron by 1.8 inches, Lake Erie by 1.44 inches and Lake Ontario by 1.20 inches. The average level since 1888 has been seven to nine inches above normal. Pursuant to a reservation in a grant by Congress, an agreement was reached in 1906 under which Lake Superior is now controlled at a level of over one foot above low water and within limits of 1.5 feet. (See Topics 23, 25 and 27.)

Lake Huron to Lake Erie had an original low water depth of about eight feet at St. Clair flats, and about 11.5 feet at Lime-Kiln Crossing, Detroit River. These depths have since been increased to 18.3 feet at St. Clair flats and to 21-2 feet near the mouth of Detroit River and to corresponding depths at other localities. The channels will all be given a uniform depth of 21-2 feet, and eventually will correspond to the Davis lock, or be about six feet deeper at St. Clair flats. The improvement plane adopted for the later projects has a declivity of 1.09 feet less, or, the level of Lake Michigan-Huron is that much lower with respect to Lake Erie. The level of Lake Michigan-Huron was permanently lowered by about 0.9 foot in 1886-90 through the enlargement of the outlet at Port Huron (Board of Engineers, 1900), and considerations herein set forth are generally corroborative.

Since the observations of 1890-1901 the capacity of this outlet has increased and the level of Lake Michigan-Huron has been correspondingly lowered by an additional 3.3 inches. There is still a surplus declivity at Port Huron and a large deepening is due in the St. Clair River, so important changes in the level of Lake Michigan-Huron are likely to occur in the absence of remedial works. (See Topics 23-25 and 27.)

The Niagara River outlet does not seem to have been changed so as to produce important results on the level of Lake Erie, during the period of record, 1860-1911. Prior records suggest that the low water limit may have been raised considerably at an early day by the development of Black Rock harbor in connection with the Erie canal. The record assumes a diversion of 2,100 cubic feet by the Erie and Welland canals, and this corresponds to a lowering of Lake Erie by more than one inch. The barge canal is to take 1,300 feet at Tonawanda, plus any additional amount that may be allowed as heretofore for water power purposes at Lockport. (See Topics 23-25 and 27.)

The Saint Lawrence River at the Galop Rapids, was deepened by the Dominion Government in 1881 and the cross-section enlarged by six to eight per cent., thus increasing the capacity by some nine to twelve per cent., corresponding to a lowering of level of one foot, more or less, provided the fluctuations of Lake Ontario are parallel to those at the Galop, and they appear to be greater. The Gut channel was closed in 1903, thus diminishing the capacity by about 5.5 per cent. and raising the level by about one-half foot. The power canal from the Saint Lawrence River above the Cornwall Canal, to Grass River at Messina Springs, has a capacity of 25,000 cubic feet, equivalent to a lowering of the Saint Lawrence River by 1.40 feet. (See Topics 25 and 30.)

The Ship Channel between Montreal and Quebec had an original limit of depth of 11 feet and was increased to 27.5 feet by 1888, with a local lowering of water level of about 1 foot at Montreal. This channel has been enlarged and increased in depth to 30 feet, and is in process of deepening to 35 feet, and such deepening covers nearly half the distance. A sensible lowering of the water plane is due to this work. (See Topics 23 and 25.)

The Changes in Plane occasioned by private corporations are pronounced. That in the Saint Lawrence above the Cornwall Canal seems to have escaped official notice. That in Lake Superior seems not to have occasioned any official action from 1888 until 1906, when an agreement was forced by the International Commission (see Rpt. on Georgian Bay Ship Canal, 1909, p. 497), but without suppressing the water power companies, and the level of Lake Superior has since been controlled within certain limits. This is a matter of some significance in view of the large ratio of diversion to outflow in this outlet. The enlargement of the outlet at Port Huron has produced a very material change in the plane of Lake Michigan-Huron and the change is still in progress, but no particular concern has been exhibited in official reports since that of the Board of Engineers in 1900. The Dominion Government has twice changed the level materially at the Galop Rapids without awakening controversy. Channel improvements have no doubt produced sensible changes in level, but official discussion thereof is meager when not quite absent. It appears, therefore, that a number of changes in level have been made exceeding that alleged against the Chicago diversion, and that such changes have largely been irresponsible and without authority or oversight, while the Chicago enterprise was properly authorized and the probable effect estimated and published prior to and during the construction of the work. It is presumed, therefore, that the request of Congress for information has particular reference to these other and unaccounted changes.

45. *Lake Fluctuations and Oscillations* from meteorological causes range through limits many times exceeding the changes in plane which are thus so masked as to be incapable of direct determination. These fluctuations so disturb the flow in the outlets, and the outlets themselves are so variable in prism and slope, that great skill is required in discharge measurements and much expert judgment in analyzing data; so it is not always clear how far difference in results may be due to data and how much to personal equations. (See Topic 27.) Changes of level, apart from changes in horizon or plane, may be classed as secular, yearly and temporary.

Secular Changes are due to persistent and long continued meteorological conditions which have produced the extremes of low and high water. The most notable fluctuation in level, during historic time, occurred in the period 1819-20 to 1838, and before man had changed conditions on the water-sheds or disturbed outlet channels. The range was, for Lake Michigan-Huron, 6.67 feet; Detroit River at Detroit, the same; Lake Erie, over 6 feet, and Lake Ontario, 6.52 feet. A second and less characteristic period occurring also before outlet channels had been materially disturbed, except the probable change in the Niagara River at Black Rock, is covered by the years 1846-8 to 1858-9. The range was, for Lake Michigan-Huron, 4.85 feet; Lake Erie, 4.58 (m. o. l.), and Lake Ontario, 4.78 feet. The third period occurred during the transformation on water-sheds and in outlet channels and is covered by the years 1886 to 1895. The range was, for Lake Michigan-Huron, 4.60 feet; Lake Erie, 3.21 feet, and Lake Ontario, 5.23 feet. The last range for Lake Michigan-Huron includes a notable change of plane due to the enlargement of the Port Huron outlet. The levels were generally low for a number of years prior to 1819, and they have also been generally low since

1895, and they were generally high between 1858 and 1886. (See Topic 26.)

The Record Period covers fifty-two years, 1860-1911. This record shows that during the thirty years, 1860-1889, the average level was above the average level for the twenty-two years, 1890-1911, by the following amounts: Lake Michigan-Huron, 1.41 feet; Lake Erie, 0.86 foot, and Lake Ontario, 0.70 foot. The difference for Lake Michigan-Huron includes the change of plane due to the enlargement at Port Huron. Lake Superior would have shown a corresponding difference had its normal level not been under control since 1888. When these differences in mean level are compared with the differences in rainfall, the cause is sufficiently apparent. (See Topics 26 and 27.) The range in yearly means for the record period was, for Lake Michigan-Huron, 3.49 feet; Lake Erie, 2.53 feet, and Lake Ontario, 3.34 feet. The range in monthly means for Lake Michigan-Huron was 4.64 feet; Lake Erie, 3.89 feet, and Lake Ontario, 5.54 feet. The greatest yearly discharges in the several outlets exceed the least by amounts ranging from thirty to sixty per cent. The greatest monthly discharges exceed the least by amounts ranging from fifty-five to one hundred and seventy per cent. (See Topic 22.) A diversion of 10,000 feet at Chicago is less than five per cent. (5%) of the average flow in the Niagara River.

The Yearly Change in Level as given by the record of monthly means for fifty-two years is as follows:

	L. Michigan-Huron. (Feet.)	Lake Erie. (Feet.)	Lake Ont. (Feet.)
Greatest yearly range....	1.94	2.28	3.65
Least yearly range........	0.59	0.87	0.79
Average yearly range....	1.21	1.53	1.93

The yearly change in stage cannot be anticipated further than that the lowest water will occur near the close of winter and the highest water near the end of the replenishing season. (See Topic 26.)

The Temporary Changes in Level are eliminated in the record of monthly means. They are due to changes in wind and barometric pressure. The phenomena known as ''sieches'' are always present and represent recurring oscillations with intervals measured by fractions of an hour, sometimes reaching an amplitude of a foot and upwards. Other changes persist for hours and sometimes continue into days. Within limits of a foot the lake surface may be considered persistently unstable and much greater limits are frequent. The subject-matter, is sufficiently presented in excerpts from official reports. (See Topic 26.)

The Natural Fluctuations, secular, yearly and temporary, are so great as to mask and render insignificant the minor effect of the Chicago Diversion. To assume that navigation is injured by a diminution of the higher stages, is an error. It is also an error to estimate the damage on the theory of the difference in the level of stable surfaces.

F. BENEFITS EXCEED DAMAGES.

46. *The Damages* due to the effect of the Chicago Diversion are officially estimated as follows: Yearly loss, $1,500,000 in round numbers; measure of damage, $12,500,000. These estimates are questioned. (See Topic 30.)

First. *The Yearly Loss* is excessive.

(*a*) The effect is reduced by later determinations, and these are not final.

(*b*) The damage is not uniform at all stages, but decreases with the stages above low water.

(*c*) The surface of the water is fluctuating and unstable, and a change of its average level is not the equivalent of a change of level in stable surfaces.

(*d*) The interest on the measure of damage is only $500,000 at four per cent. (4%), and only $250,000 at the government rate of two per cent. (2%).

Second. *The Measure of Damage* is excessive.

(*a*) The estimate is for an independent additional depth of one foot in channels, harbors and canals, in the United States and Canada, as a measure of any lesser depth. Such foot by the latest determination is equivalent to a diversion of 22,500 feet for Lake Michigan-Huron, 22,000 feet for Lake Erie and 27,000 feet for Lake Ontario, or fifty per cent. (50%) in excess of the aggregate capacity of the Drainage Canal and the Illinois and Michigan Canal (15,000 feet).

(*b*) The Terminal locks of the several Canadian canals differ in depth by more than 2 feet and conditions are met by correcting those of least depth. (See Topic 23.)

(*c*) The effect, in part, can be corrected at less cost by "compensating works" in the outlets.

(*d*) The cost will be lessened and inconvenience avoided by making the extra depth an incident of the existing policy of progressive deepening of channels, harbors and canals.

Third. *Prospective Damage* is not necessarily a real damage. Channels and harbors, during and since the construction of the Drainage Canal, have been progressively deepened by many times the alleged effect. If the increased draft has been less than anticipated, can a damage be predicated on a failure to obtain something not before possessed?

Objections Are Waived, however, under this heading, for the purpose of comparing alleged damages with real benefits.

47. *The Expenditures* on the Chicago Sanitary and Waterway program up to January 1, 1912, have been $75,231,295.53. No estimate for completion has been made, but the total may be taken provisionally at $100,000,000. The state has authorized by popular vote, 1908, an expenditure of $20,000,000 on the Illinois River between Lockport and Utica, and the United States is expected to co-operate with $16,000,000 additional between Lockport and the Mississippi River. (See Topic Nos. 5 and 15.)

Collateral Expenditures under the same general policy have been and are being made by the Park Boards in a system of parkways along the lake front which protect the purity of the water supply;

but the amount involved, though large, is not estimated. The city is expending $5,000,000 on harbor bridges, and has recently been authorized to expend $5,000,000 on harbor extension. The expenditures by the United States up to June 30, 1911, for Chicago harbor and Calumet, including Indiana harbor, have been $6,533,340.55. The City of Chicago made all the expenditures for the development of its river harbor prior to 1896. The amount is large, but it has not been compiled.

The Hennepin Canal (Illinois and Mississippi) has cost the United States, to June 30, 1911, the sum of $7,508,680.28, but the usefulness of this work is largely predicated on the development of the work between Lockport and Utica. The State of Illinois expended in the construction of the Illinois and Michigan Canal and in the improvement of the Illinois River, $10,260,769.00. (See Topic 37.) The United States has expended to June 30, 1911, for surveys and improvements between Chicago and the Mississippi River, $2,325,597.73. (See Topic 38.) The Deep Waterway will make obsolete in part the canal and river work.

The Great Lakes have incurred a total expenditure by the United States, to June 30, 1911, for surveys, and channel and harbor improvements, of $106,205,936.64. Omitting expenditures for the Chicago District, $6,533,340.55, the expenditures for Lake Superior and the Saint Mary's Falls Canal, $19,717,482.71, and for lake and seaboard surveys, $3,392,394.45, the remainder is $76,562,717.93, which presumably represents works adversely affected by the Chicago Diversion. (See Topic 33.) It will be noted that this amount does not differ materially from the direct expenditures already made at Chicago, and is much less than the sum actually authorized, and still less when collateral expenditures are included. On the extreme assumption, the value of federal works is impaired only in a minor degree, while any substantial interference with the Illinois program represents enormous loss and confusion.

The Canadian Expenditures on the works now under the Dominion Government, between the head of Lake Superior and Quebec, has been $90,089,382.98. This does not include local harbor expenditures, but is for canals and channels, part of which are not affected by the Chicago Diversion. (See Topic 33.) The total as given, however, is less than the amount involved in the Chicago sanitary problem alone. Any injury is minor and insignificant compared to interference with the Illinois program. The Canadian question is treated separately in Division H.

48. *The Population* of the Sanitary District of Chicago, by the Federal Census of 1910, is 2,311,810, to which may be added the urban Calumet population in Indiana (63,412), making a total of 2,375,222. The urban population contiguous to the water route between the Sanitary District and the Mississippi River has an identical Sanitary and Waterway interest, and aggregates 208,679. The urban population directly interested, is, therefore, 2,583,901, the Illinois portion thereof being about seventy-two per cent. (72%) of the urban population of the state. The additional urban population in the Illinois River Basin, less directly interested, is 158,652, and the total is about seventy-seven per cent. (77%) of that of the state. (See Topics 2 and 20.)

The Waterside Urban Population between the mouth of the Illinois River and the Gulf of Mexico is 1,346,648, and this, together with that adjacent to the Illinois River and in the Chicago District of Illinois and Indiana, makes a total of 3,930,549, increased to 4,089,201 by adding the other urban population of the Illinois River Basin. (See Topic 20.)

The Lakeside Urban Population outside the Chicago District and below the level of Lake Superior, down to and including Niagara Falls, by Federal census of 1910 and Canadian census of 1911, is 2,889,530, of which the Canadian population is 96,317. (See Topic 32.) The interests of Canada are relatively nominal. The aggregate above Niagara Falls only exceeds the aggregate directly interested in the Illinois Sanitary and Waterway program by 305,629, or about twelve per cent. (12%), and this difference is nearly made up by the Illinois urban population back in the Illinois River Basin and along the Mississippi River between the Illinois and Ohio Rivers, aggregating 281,430. It will be noted that the population vitally concerned in the Illinois program (2,583,901), has received the fostering care of the general government to the extent of $8,858,938.28 (Illinois R., Chicago and Calumet), while the lakeside population of the United States, between Lake Superior and Niagara Falls (2,793,213) has been encouraged to the extent of $48,106,531.34. The chief complainant is a beneficiary and is thereby slightly affected, while the party complained of is expending his own resources in a project vital to his welfare.

Below Niagara and down to the international boundary the population in the United States is relatively small, or 260,401, including Rochester. The Canadian population down to actual tidewater is relatively large, or 1,027,321. (See Topic 32.) The interests of navigation are relatively small and the effects of the Chicago Diversion are less significant. The problem here is largely Canadian and referred to later. The aggregate population interested is 1,287,722, and it holds about the same relation to the upper lakes as the somewhat greater population between the mouth of the Illinois River and the Gulf of Mexico, or 1,346,648, holds to the Illinois project, and its concern is much less important.

The Aggregate Population about the Great Lakes and along the Saint Lawrence, between Lake Superior and actual tidewater, is 4,177,253, of which 1,123,638 is in Canada; while the aggregate urban population between Lake Michigan and the Gulf of Mexico (Illinois River Basin included) is 4,089,201, practically the same and all in the United States. The interests to the east are at most but slightly affected and are in large degree the beneficiaries of government patronage, while the interests toward the south are most vitally concerned and are making enormous expenditures along the lines of conservation and waterway development, with relatively small government patronage. The potential value toward the south and its ability to carry population, is beyond comparison and it is backed by a great hinterland and reinforced by tributaries reaching to the confines of the interior valley.

49. *The Direct Benefits* can be estimated in part and approximately. A flow of 15,000 feet per second at Chicago, under the lawful minimum ratio of dilution, is adequate to a population of 4,500,000, to be attained in some thirty years, in or about 1940. The same flow by reason of self-purification en route, is adequate to any prospective population in the Illinois valley. Incidentally and on an ultimate development, it will produce 185,000 effective horse power on the turbine-shaft in the valley between Lockport and Utica. Such flow makes possible a deep, capacious and stable channel of the Illinois River between Utica and its mouth and thus facilitates the reclamation of bottom lands, and adds to the healthfulness of the valley. It further increases the value of fisheries, already extensive. There are many other enhancements and in addition to all, the value of the deep waterway itself.

First: *The Sanitary Value* to Chicago may be taken at the cost of an alternative method of sewage treatment, or $30 per capita, including capitalized cost of maintenance and operation... This is less effective and loses sight of harbor and waterway advantages.	$135,000,000
Second. *The Sanitary Value* to the Illinois Valley may be taken on the same basis, for a population of 1,000,000, or This population will grow rapidly through water-power development and land reclamation, not incident to other methods, and there are also collateral advantages.	$30,000,000
Third. *The Water Power* between Lockport and Utica will pay a return on $400 per H. P. and this is incidental..	$74,000,000

Fourth. *Reclamation* of the overflow lands below Utica will add to the healthfulness of the valley and enhance the value of some 400,000 acres of alluvium by (See address, Association of Drainage & Levee Districts of Illinois, Peoria, July 18, 1911.)	$67,000,000
Fifth. *The Fisheries* have already attained a commercial value of $800,000 per year (double to the consumer) and may be listed for ultimate development at double, or $1,600,000 capitalized at 4 per cent. (4%)	$40,000,000
Sixth. *Collateral Enhancements* in real estate, and in transportation facilities will add a large item	No estimate
Seventh. *The Deep Waterway* will have a very large value	No estimate

The Direct Values are more than $346,000,000. It will be noted in passing that the fisheries of the Illinois valley exceed in value all the damages alleged by reason of the effect of the Chicago Diversion.

The Middle Mississippi, under the tentative waterway project of the Lakes-to-the-Gulf Deep Waterway Association will produce 400,000 horse-power, to be doubled on ultimate development and water conservation (see testimony before House and Senate Committees, Washington, 1910).

The Lower Mississippi delta lands are under reclamation largely at the cost of the six levee states and embrace some 20,000,000 acres. Their ultimate security is insured by the deep waterway with its permanent protection of banks and eventual lowering of the flood line. *The Evolution of the Sanitary*

Project underlying the law is historically treated in Topic 39.

The Indirect Value depends on the value of human life, the worth of good health and on how many more people may be given opportunity for better means of livelihood. The price of unnecessary death is the subject of statutes and the cost of unnecessary sickness and ill health is the theme of health officers, malaria alone representing a greater economic loss than any other item in our welfare. Water power towns develop on the basis of three to five people per horse-power; the alluvium of Egypt carried two people per acre, the alluvium of China and Japan now carries three to four people per acre. Transportation itself is a great economic factor. With wealth in the census on the basis of $1,200 per capita, some idea may be formed of the potential significance of the Illinois enterprise.

50. *The Foregoing Analyses,* on every consideration, shows enormous benefits in proportion to damages and that such damages are in the nature of minor interferences and inconveniences rather than prohibitory or confiscatory. Equity forbids action in the nature of injunction and redress must invoke other procedure.

Comity among Utilities, as developed in the bridge cases, is a doctrine in parallel. The common welfare demands that every resource shall be utilized and that every facility and convenience shall be availed of, and thus may be incurred some hardship, interference or inconvenience to prior enjoyments, but the damage is without redress. A bridge may cross a stream, thus increasing the hazard of navigation and changing its method, putting down smoke-stacks and compelling other adaptations; or, one railway may cross another, compelling stoppage of trains, interlocking signals and watchmen. The prior enjoyment shall be interfered with as little as practicable without undue burden on the newcomer.

The Complainant should see his redress in the increment to the common welfare which increases the value to every shareholder. Chicago is the greatest of lake cities, with the largest hinterland and the widest railway system, and she has a greater interest, present and potential, than any other lake city, and perhaps all others, in the development of lake conditions. Her development and the use which she shall make of the lake waterways is shared by every other lake community. The resources which Illinois is developing will contribute in some degree to every port. The water route to the Gulf and its tributaries as well will be available to all alike. In this enjoyment of what is being provided by others, should not a contributory policy replace an ungracious attitude, at least to the extent of a co-operative spirit before the national councils?

G. REMEDIES.

51. *The Argument* under E (Topics 43, 44 and 45) contends that no material damage is occasioned by the diversion at Chicago. The argument under F (Topics 46-50) assumes damages and shows that the benefits are relatively very great. The argument under this head (G) shows that any and every effect may be adequately remedied and that every prior enjoyment may thus be preserved. Under such circumstances objection becomes frivolous, querulous and wilful, and the responsibility only remains (see Topic 52). A variety of remedies are feasible, varying with the locality and the purpose.

(*a*) Lake Superior is already under control by reason of water power diversion at St. Mary's Falls, and for the purpose of giving a better navigation level. The Dominion Government has twice shown (1881 and 1903) that the Ontario level can be readily changed by works at the Galop Rapids. The Lake Erie level was probably changed at an early day through constriction of the outlet at Black Rock. The International Waterways Commission concludes that changes in level due to diversion and enlarged outlets can be "compensated," and a special report thereon is due; and this method has been referred to in official reports for nearly twenty years. Control of the level of Lake Erie will to a less degree control the level of Lake Michigan-Huron and is so set forth in two official reports (see Topic 31).

(*b*) Official estimates have been made of the cost of deepening harbors, outlet channels and canals, by an extra foot, thus permitting a diversion of 22,500 feet at Chicago, and such estimate will be greatly reduced if the work is made incidental to the progressive increase now under way or predicated. A general lowering of lake level by one foot would have compensating advantages through a greater freeboard to the low-lying districts of lake cities (see Topics 29, 30 and 31).

(*c*) Conservation suggests a better utilization of these natural reservoirs through a full control of flow in the outlets and the use of the storage capacity within high water limits. Experience with Lake Superior has demonstrated that levels below may be thus influenced. Such a program aided by auxiliary dams and contraction works would enable the diversion of any amount of water that might be justified or desired without impairing any prior enjoyment. Such a policy would not necessarily reduce the minimum flow by the St. Lawrence outlet, and such flow is habitually taken as the basis for improvements and for power.

(*d*) Further elucidation of the subject-matter is promised in the closing report of the International Waterways Commission. The Special Board of Engineers, appointed in 1910, is to report on "such measures as may be required to properly preserve the levels" and "to compensate * * * the diversion * * * for the maintenance of the proposed waterway," etc. The instructions breathe a co-operative spirit, and both reports are overdue. The effect of diversion is thus far nominal and the determination of remedies will doubtless discount the alleged major effects.

Some Stress has been laid on the greater power that could be produced by the water in the direction of the Saint Lawrence and comparison has been made between the fall in Illinois and in the Niagara and Saint Lawrence Rivers. The point is not germane, as water-power is only an incident and not a purpose in the Illinois enterprise. The statement is not even technically true. Water power will be developed as far as Cairo and the fall utilized will not differ so greatly from that actually available in the other direction; furthermore, the supporting ground will not carry the population required to utilize all the power that can be developed in the natural outlets, while the potential market to the southward is unlimited. It is in fact a question of conservation. (See note, Appendix No. 1.)

52. *The Responsibility* for remedies rests in the General Government, as the jurisdiction of the State of Illinois does not extend territorially or by function to matters interstate or foreign. A prerogative or privilege expresses a better meaning, and Congress seems to have recognized this, somewhat tardily, perhaps, in its instructions to two boards of engineers. When a state engages in the development of its resources in a matter vital to its welfare, and thereby contributes in a large way to means of interstate and foreign commerce, the outside relations are up to the United States. The broader jurisdiction is for the benefit of all the states; it is not despotic or coercive along economic lines, but should be and is co-operative and helpful to the sovereign state which has delegated its powers in relation to other states and foreign nations.

An Incidental Expenditure is involved, relatively small in amount, and this is a proper and necessary part of the program for the progressive and ultimate development of outlet channels and harbors. No nice distinction need be drawn respecting an enterprise so broad in its relations. Are the beneficiaries of some six times the federal patronage (see Topic 48) thus endowed with special rights against an equal group of population that are working out their own destiny?

PART III.

Foreign Relations and Conclusions.

H. Canada.

53 *The Canadian Grievance* respecting the Chicago Diversion is based on effects which differ in locality and degree, but are otherwise the same as pertain to the opposite shores in the United States. The facts and issues have been so fully presented that only the singular conditions and omissions are here referred to.

(*a*) *The Upper Lakes Effects* relate only to harbors of the Canadian shore between St. Mary's River and Niagara Falls, including the upper level of the Welland Canal. The urban population aggregates 96,317 at seventeen ports (census 1911), or is 3.5 per cent. of that in the United States at sixty-two ports (2,793,213), and is but 3.7 per cent of the population directly interested in the Illinois enterprise (2,583,901). Canadian tonnage is but six per cent. (6%) of the American tonnage passing St. Mary's Falls, and the proportion is less for the whole upper lake system. The outlet channels, except the Canadian lock at the Soo, have been improved at the sole cost of the United States and are used on equal terms. The Canadian interests are so minor that she can safely rely upon such redress as the major interests in the United States deem sufficient in their own behalf, and this is understood to have been the attitude of the Dominion Government up to a recent time. It is presumed that Canada will co-operate in any remedial works, at least to the extent of providing for any necessary shore connections, and that the objections made to such works near the mouth of the Detroit River (see Topic 25) were simply to remind the United States of the existence of Canada.

(*b*) *The Lake Ontario Effects* relate to the Canadian shore from the Niagara River to the Galop Rapids, to certain local canals or cut-offs, and to the seaboard route between Lake Erie and Montreal. The effects here are less and more remote from the cause and the total commerce is a minor fraction of that of the Upper Lakes. The major interest is Canadian and her urban shore population is 527,062 at thirteen ports, or double that of the United States, which is 260,401, including Rochester. The scale of navigation is that of the canal system, or a depth of 14 feet as against 21-2 feet for the Upper Lakes, but the new Welland is being promoted for a depth of 24 feet, thus corresponding to the Davis lock at the Soo and the Chicago Drainage Canal (Toronto Harbor Board). Such a project would swallow any effect in the deeper channels and harbors of Lake Ontario. The direct remedy is simple and amply demonstrated in the work of the Canadian Government at the Galop Rapids in 1881 and 1903 (see Topics 25, 27 and 44), by which the level was first lowered by about one foot and since restored by about one-half foot, or sufficient to compensate the alleged effect of the Chicago Diversion, and seemingly in anticipation thereof. (See Topics 22-27 and 44.)

(*c*) *The Saint Lawrence River,* with its canals from the Galop Rapids and the international boundary to Montreal, is essentially a channel of passage, its urban population being only 26,746 at Cornwall, Valleyfield and Lachine. The International Waterways Commission did not estimate effects below the boundary line, presumably from lack of data rather than the lack of international importance. The Commission overlooked the sensible effect of the water power diversion above the Cornwall Canal. (See Topic 25.) In view of the parallelism of effects down to the Cornwall Canal, as given by the Commission, it is presumed that like effects will continue to the vicinity of Montreal, subject to local conditions, water power diversions and increased volume from tributaries. Attention has already been called to the lack of uniformity in the depth of the entrance locks to the several canals and that only those which are relatively deficient will require change. (See Topics 23 and 30.) Such changes suggest themselves in the interest of a commensurate canal system. It is presumed that all the levels in the Saint Lawrence River may be readily controlled through compensating works, as already indicated at the Galop and at St. Mary's Falls.

(*d*) *The Saint Lawrence Ship Channel* between Montreal and Quebec has developed the leading ocean port in the Dominion—Montreal—and is thereby the most important public work. The tide at low stages runs up to the foot of Lake St. Peter, and any sensible effect due to diversion is practically limited to that portion of the channel between the head of Montreal harbor and Lake St. Peter, a distance of about forty-six miles. The urban population is limited to Montreal and its suburbs, aggregating 473,513. No sufficient data are in hand by which to discuss the probable effects at Montreal. The Ship Channel and harbor are pre-eminently progressive works, so any damage amounts to a deficiency in an anticipated result and belongs to the future. Progressive deepening of channels means a progressive lowering of the water surface, which must be met by lowering the bottom or by compensating works, and the remedy is of the same nature.

The Canadian Population between Lake Superior and tidewater aggregates 1,123,638, or about thirty-six per cent. (36%) of the American population (3,053,614) between Lake Superior and the international boundary, and about forty-three per cent. (43%) of the population directly interested in the Illinois enterprise (2,583,901) between Lake Michigan and the Mississippi River.

Another Remedy is suggested through such reservoir control as will better equalize or maintain the minimum flow in the outlets, and such remedy would cancel all effects due to extraneous causes. In view of overdue official reports and recent Canadian activity, additional light respecting remedies is expected.

54. *No distinction* has thus far been made by reason of diverse sovereignty, and the appearance of Canada before the Secretary of War (February 28 and March 27, 1912) is too pleasant an omen to suggest any lack of redress under existing treaties and international usage. If the Canadian complaint is presented and entertained on a domestic or interstate basis, the subject-matter has been sufficiently covered. International usage, however, proceeds on different lines except as interests are merged by treaties, and this phase of the question invites examination.

The Spirit of Comity which has governed the relations between Great Britain and the United States is sufficiently evident in diplomatic intercourse and treaty provisions, and certain pertinent matters are here referred to.

The Treaty of Partition proclaimed April 11, 1783, provided that (Art. VIII):

> "The navigation of the River Mississippi, from its source to the ocean, shall forever remain free and open to the subjects of Great Britain and the citizens of the United States."

This Article was inoperative by reason of the later discovered fact that the Mississippi did not originate on British territory, north of the boundary line.

An Arrangement, proclaimed April 28, 1818, forbids war fleets on the Great Lakes and limits each power to vessels of 100 tons burthen, each, armed with a single eighteen-pounder, two for the Upper Lakes, one for Lake Ontario and one for Lake Champlain.

The Reciprocity Treaty, proclaimed September 11, 1854, for a term of ten years plus two years after notice, abrogated March 17, 1866, provided for "the right to navigate the River Saint Lawrence and the canals in Canada used as the means of communicating between the Great Lakes and the Atlantic Ocean" on equal terms, and reciprocal rights were extended to Lake Michigan, and the United

States undertakes to urge upon the States similar rights in State canals.

The Treaty of Washington, proclaimed July 4, 1871, provided (Art. XXVIII) for the free navigation of Lake Michigan for a term of ten years, but "not considered in effect" is the notation in the volume on treaties. The treaty provides that (Art. XXVI):

> "The navigation of the River Saint Lawrence, ascending and descending, from the forty-fifth parallel of north latitude, where it ceases to form the boundary between the two countries, from, to and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain, or of the Dominion of Canada, not inconsistent with such privilege of free navigation." (Like provision respecting Yukon, Porcupine and Stikine Rivers in Alaska.)

The Treaty further provides that (Art. XXVII):

> "The Government of Her Britannic Majesty engages to urge upon the Government of the Dominion of Canada to secure to the citizens of the United States the use of the Welland, St. Lawrence and other canals in the Dominion on terms of equality with the inhabitants of the Dominion; and the Government of the United States engages that the subjects of Her Britannic Majesty shall enjoy the use of the St. Clair Flats Canal on terms of equality with the inhabitants of the United States, and further engages to urge upon the State Governments to secure to the subjects of Her Britannic Majesty the use of the several state canals connected with the navigation of the lakes and rivers traversed by and contiguous to the boundary line between the possessions of the high contracting parties, on terms of equality with the inhabitants of the United States."

The St. Mary's Falls Canal came later into the possession of the United States and has since been operated under the spirit of the treaty, as likewise the Canadian canal opposite.

The Treaty on Boundary Waters, proclaimed May 13, 1910, in force for five years after ratification, May 5, 1910, and until one year after written notice by either party, relates in terms to the "common frontier," except that the right of common navigation is extended to Lake Michigan for the time of the treaty. The treaty recognizes the common use of boundary waters and appurtenant canals, defines such waters and the use and maintenance of the same, and is largely devoted to providing redress and consideration for interferences. The citizens of one country may bring issues in the courts of the other (Art. II); identical legislation has the force of an agreement (Art. XIII), and a Joint Commission is constituted to determine grievances and consider propositions, and is endowed with certain advisory powers. Of the fourteen articles, six (VII to XII inc.) pertain to the organization and jurisdiction of the Commission, and such jurisdiction is also extended to two other Articles (III and IV), one Article pertains to the Niagara River (V) and one Article to irrigation (VI), while two Articles are general. In the use of waters, "this order of precedence" is stated (Art. VIII):

> "(1) Uses for domestic and sanitary purposes.
> (2) Uses for navigation, including the service of canals for the purposes of navigation.
> (3) Uses for power and irrigation purposes."

The spirit of the treaty is, to protect and regulate the use of boundary waters. Such waters are defined in the Preliminary Article:

> "For the purposes of this treaty boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers and waterways, or waters flowing from such lakes, rivers and waterways, or the waters of rivers flowing across the boundary."

55. *Territorial Rights* are jealously guarded in the last treaty. The common right of navigation in boundary waters and the River Saint Lawrence to the sea, and appurtenant canals, was temporarily recognized in the treaty of 1854, was made permanent in the treaty of 1871 and better defined in the treaty of 1910. Lake Michigan has always been recognized as territorial waters of the United States, and in each of the three treaties the right of navigation has been granted for a limited term of years. On such temporary grant Canada has based a right of protest against local harbor conditions at Chicago. (Hearing before Secretary of War, March 27, 1912, pp. 8-9, Canadian Rpt.) If such claim be admissible, the United States has a much clearer right to interfere with Canadian harbors, all of which are boundary waters by definition, and a still larger concern in the outlet between the international boundary and the sea. The genius of the treaty relates to channel improvements and diversions along the "common frontier," and the effect of all such works on lake levels and the works themselves, so far as on common territory and extra-territorial, are under the jurisdiction of the Joint Commission. It thus appears that projected improvements must invoke international consideration prior to appropriation and execution, with whatever embarrassment and delay such course may entail. A suggestion in point is the "Order in Council," January 11, 1911, respecting compensating works near the mouth of the Detroit River (*ibid,* p. 213.) The effort to stretch this treaty to Chicago raises unwelcome inferences and implications.

Prior Acts and Accomplished Facts are particularly excluded in reiterated terms from the operation of the last treaty, as though guarding against *ex post facto* interpretations. The implication is expressed in the following words:

> ARTICLE II. "Shall not apply to cases already existing;
> ARTICLE III. "uses, obstructions and diversions heretofore permitted," and "existing rights;"
> ARTICLE V. "investments which have already been made;"
> ARTICLE VIII. "shall not apply to or disturb any existing uses."

The Chicago Drainage Canal was opened ten years prior to this treaty and it was confirmed on the basis of a natural outlet four years prior by the Supreme Court of the United States. Its probable effects on lake levels were sufficiently understood prior to and during its construction, and more than twenty years before the treaty. The channel in its full capacity was actually enacted on the ground, in the sight of all men, and without adverse question from any quarter, and the right to construct presumes the right to use. It is not clear, therefore, how this work can be brought within the scope of the treaty. (See Topics 28, 41 and 42.)

The Canadian Contention, as stated by counsel at close of oral argument (hearing before Secretary of War, March 27, 1912, p, 35, Canadian Rpt.), rests particularly on Article II: "I invoke that second clause, and I also stand on the general rights under the treaty obligations of the two countries, and also the comity existing between the countries." Counsel reserves right to raise before the Joint Commission an issue under Article III, respecting incidental effect of diversion from tributary waters. Counsel in his general argument claims that the words "ordinary use" as applied to "domestic and sanitary purposes" in Article III also apply inferentially to "uses for domestic and sanitary purposes" in Article VIII (identical language in Art. V), thus excluding the dilution method, and counsel adds much gratuitous advise respecting proper methods of sewage disposal at Chicago. Counsel further deprecates the use of water for waterway purposes and cites report of Special Board of Engineers, January 23, 1911, adverse to a volume exceeding 1,000 feet, and the whole Illinois program.

The Complete Reservation to the United States and the States of all territorial rights, is the subject-matter of Article II, and it determines procedure in case of injury. The issue is a question of damage.

It is to be observed that the so-called report of the Special Board has been virtually withdrawn (see President's Message, Topic 18), and the actual report is subject to conference with duly authorized officials of the State of Illinois, not yet provided for, and that final action is concurrent by the Congress of the United States and the General Assembly of Illinois. In other words, this is a government of the people, expressing itself through legislative bodies, rather than appointed boards.

Prior Right of Use is expressed in the following order (Art. VIII):

> "(1) Uses for domestic and sanitary purposes;
> (2) Uses for navigation, including the service of canals for the purpose of navigation;
> (3) Uses for power and for irrigation purposes.
>
> No use shall be permitted which tends materially to conflict with or restrain any other use which is given precedence over it in this order of precedence."

The use in Illinois is not separate, individual or alternative, but combines in the same order of merit all the uses recognized by the treaty and is thus complete conservation and in accordance with the highest principles of public policy and recognized in this treaty.

The Chicago Diversion is not mentioned in the treaty and so prominent and well known a work could not have escaped notice. It must be presumed therefore that it was intentionally excluded from the operation of the treaty and such is known to be the fact.

(*a*) The General Assembly of Illinois in special session, 1906, by joint resolution, protested against any restriction of flow through the Drainage Canal by legislative act or by "any treaty to be entered into with a foreign power," and a copy thereof was sent immediately to the President, the Secretary of State, and to the two Senators and the Representatives in Congress from Illinois, and the same was heeded.

(*b*) The draft of the treaty was fully considered by the U. S. Senate, a part of the treaty making power, and this question was not overlooked.

(*c*) A high official concerned in the preparation of the treaty has stated to the undersigned, that if the treaty contained anything bearing upon this question it was because they did not know how to exclude it.

56. *A Parallel Case* relates to the Rio Grande, a boundary water between the United States and Mexico. The treaty of Guadalupe-Hidalgo, proclaimed July 4, 1848, provides in Article VII (still in force).

> "* * * that part of the Rio Bravo del Norte (Rio Grande) lying below the southern boundary of New Mexico, being agreeably to the fifth article, divided in the middle between the two republics, the navigation * * * of the Bravo below said boundary shall be free and common to the vessels and citizens of both countries; and neither shall without the consent of the other construct any work that may impede or interrupt in whole or in part the exercise of this right; not even for the purpose of favoring new methods of navigation."

Mexico complains (October 21, 1895) that her citizens in the El Paso district have enjoyed the undisturbed use for irrigation of the waters of the Rio Grande for more than 300 years and that through the digging of trenches and the application of the waters in Colorado and New Mexico the flow became so small and uncertain, that a population of 20,000 in 1875, has been reduced to half the number and greatly impoverished in 1894, and represents that no more serious interference could occur than to "wholly turn aside the water of these rivers."

The Complaint and accompanying papers are referred by the State Department (November 5, 1895) to the Attorney-General for a legal opinion (December 12, 1895,—Official Opinion of Attorneys General of the United States, p. 274-284). It is concluded that the damage is without redress. A Convention between the United States and Mexico, proclaimed January 16, 1907, provides that a certain quantity of water from a storage dam on the Rio Grande in New Mexico, shall be delivered in the river bed opposite the head of the Mexican canal, said quantity in seasons of scarcity to be diminished in like proportion with that used in the United States. Mexico relinquishes all other claims to the use of water to Fort Quitman, Texas, and waives all prior claims on account of diversion and use in the United States. "Being moved by considerations of international comity" and "desirous to provide for the equitable distribution of the waters of the Rio Grande," express the motive for the treaty. All legal responsibility and all claims before made are expressly renounced, "Nor does the United States in any way concede the establishment of any general principle or precedent by the concluding of this treaty."

The Opinion of the Attorney General, Judson Harmon, goes into the merits of the question in respect to physical conditions, sovereign rights, treaty limitations and international usage. Some relevant points are mentioned below:

(*a*) The navigation of the Rio Grande is interrupted at a point some 150 miles by land below El Paso, and "so far as appears, the large and numerous tributaries below El Paso supply a sufficient volume of water for the needs of navigation," and this branch of the subject is dismissed as having "no support in the treaty."

(*b*) The contention of Mexico denies to the people of Colorado and New Mexico the right to develop their own resources and requires such an exercise of the power of eminent domain as would relegate these regions to a state of nature.

(*c*) International usage forbids a change in the locality or the nature of servitude, but permits a diminution in the amount thereof; in other words, a proprietor may use the waters that originate on or come to his lands, but he must pass the remainder at the same locality and in a condition for use by a lower proprietor.

(*d*) "No believer in the doctrine of natural servitudes has ever suggested one which would interfere with the enjoyment by a nation within its own territory of whatever was necessary to the development of its resources or the comfort of its people" (p. 282).

(*e*) "The rules, principles, and precedents of international law impose no liability or obligation upon the United States" (p. 283).

The Illinois Country is endowed with a physical opportunity or resource which has been recognized from the beginning and which determined the boundaries of the State, and its development has been a fixed state and national policy for nearly a century. All the principles laid down in the Harmon opinion are applicable in greater or less degree, and it should be read in full.

Conservation in any large way must appropriate the waters for beneficial uses and change servitudes. Regions of meager water supplies, through the ages, have dedicated all water to beneficial uses and determined precedence in use in time of scarcity. Proprietorship is not in the water but in the use thereof and the individual right merges in the common need. In humid lands and in a rudimentary way, the same rules govern beneficial use and as such uses multiply, the doctrine of idle waters attenuates and fades away.

57. *Comity* recognizes equity when the right to demand is absent. The interests affected in the United States are compensated through the enjoyment of the benefits which can be shared in part only by Canada unless she shall acquire the right of navigation in the deep waterway between the Lakes and the Gulf. Canada has relatively a large frontier on the lakes with a great and favorably located hinterland, and her potential interest in such waterway and certain expansions thereof is proportionately as great as that of the United States. Through it a large part of her domain may best reach other dominions of her sovereign, and the alien shores of the American Mediterranean, and by way of the Panama Canal, best communicate with her Pacific frontier and her sister dominions beyond the sea.

The Right of a Nation to follow to the sea the waters that originate on its soil, however viewed in international law, has been conceded by usage or treaty in all the countries of Europe where rivers pass through two or more jurisdictions, and even international commissions have been constituted for the improvement of such streams in the joint interest. This right was claimed by the United States respecting the river St. Lawrence and was made perpetual in the treaty of 1871, and the same rights were extended to the rivers of Canada which crossed the Alaskan frontier on their way to the sea.

The Treaty of 1782, the first between the United States and Great Britain, reserves to the subjects of His Britannic Majesty the right of navigation in the Mississippi River to the sea on the supposed fact of its origin on British soil.

The treaty of 1871 contemplated the use of state and provincial canals connected with the lakes (see Topic 54) and the State of Illinois passed the following Act in 1872 (App. Apr. 4th, in force July 1st):

> "That when the Dominion of Canada shall have secured to the citizens of the United States the use of the Welland, St. Lawrence and other canals in the Dominion, on terms of equality with the inhabitants of the Dominion, and proper official notice of the same shall have been communicated to the President of the United States, then the use of the Illinois and Michigan Canal, and all other canals that may be constructed by this State, connected with the navigation of the lakes or rivers traversed by or contiguous to the boundary line between the possessions of the high contracting parties, is hereby granted to the subjects of her Britannic ma-

> jesty on terms of equality with the inhabitants of the United States.''

This Act may not be within the purview of the treaty and partial research, some time since, failed to disclose any official communication relating thereto between the United States and the State of Illinois. The law is still on the statute books and it applies to the waterway under construction.

The Canadian Right to use the deep waterway has thus been discounted well in advance. Had the treaty of 1782 respecting the Mississippi River been operative, Canadian vessels could have passed this way to the ocean during the periods covered by navigation rights in Lake Michigan, so far as Illinois could give them the power so to do. The policies already recognized and the equity claims on comity, invite the same status for the Lakes and Gulf route as now pertains to the St. Lawrence route below the international boundary. In view of this situation and the official attitude of Illinois long prior to the works complained of, is not the present attitude of Canada a trifle ungracious?

I. Resume.

58. *The Essential Facts* are set forth in Part 1, and are here concisely outlined as follows:

(*a*) *The Chicago Drainage Canal* is a public work authorized by the State of Illinois in 1889, and constructed by the Sanitary District of Chicago, a *quasi* municipal corporation. It leaves the Chicago River at a point six miles from Lake Michigan and extends thirty miles to the Desplaines River above Joliet. Work actually began in September, 1892, and it was opened in January, 1900. It has an estimated capacity of 14,000 cubic feet of water per second at the low water level of 1847 in Lake Michigan, and such volume can be passed when certain auxiliary work between said canal and the lake is completed. It has been operated for about one-third this capacity or about 4,800 cubic feet per second while the population in 1910 was 2,311,810 and required a flow of 7,706 cubic feet per second. The Sanitary District and the City of Chicago have expended to January 1, 1912, on account of this work and its adjuncts and collaterals $75,231.295.53, and the amount required to complete will raise the total above $100,000,000. Co-operative agencies have made expenditures and other large expenditures are predicated. The Illinois and Michigan Canal was used for Sanitary purposes prior to the Drainage Canal and was operated for a volume of 1,000 feet per second and has a possible capacity of 1,500 feet. The total capacity is 15,000 to 15,500 cubic feet per second, and this is adequate to a population of four and one-half millions to be attained some thirty years hence.

(*b*) The Deep Waterway to the Mississippi River is made possible and becomes necessary by reason of the flow in the Drainage Canal. The policy of the state was fully defined in 1889, in the Sanitary District Act and in contemporary and subsequent legislation. In 1908, the people authorized the general assembly to expend twenty million dollars in extending the deep waterway from the end of the Drainage Canal to the head of the alluvial valley at Utica, and for the development of the incidental water power. The federal government is expected to aid in completing the program to the Mississippi River. Work has been and is being grievously delayed in the courts by private water power corporations which seek to appropriate the fruits of public expenditure. The people between Lake Michigan and the Gulf of Mexico are organized in favor of a waterway which shall have a preliminary depth of fourteen feet with structures adapted to an ultimate depth of twenty-four feet, and this is the practical expression of the policy of the State of Illinois as determined in conjunction with Sanitary District legislation. The population directly interested is 4,089,201, of which 2,742,553 is in the Illinois River basin and at the southwest angle of Lake Michigan.

(*c*) *The Great Lakes* above Niagara have a water area of 87,895 square miles and an average outflow of 211,300 cubic feet per second, and the low water elevation of 1847 for Lake Michigan-Huron is 579.95 feet above mean sea level, by adjustment of 1903. The natural channels between Buffalo, Chicago and Duluth have been deepened from an original low water limit of about eight feet to a present depth of 21-2 feet and depths of 23-4 feet are predicated by the Davis lock. Below Niagara, harbors, canals and channels are developed on a basis of 14 feet. Below Montreal, depths have been increased from 11 feet to 30 feet, and 35 feet is being developed. These improvements and other interferences have materially changed lake levels. Natural fluctuations secular, yearly and temporary, are such that changes in level by direct observation are incapable of determination. Observations for determining effects by the principles of hydraulics were not undertaken until the Chicago Drainage Canal had been substantially completed and the results deduced are still undergoing revision from later observations. The effects from the Chicago diversion are uncertain and differently estimated and are minor in comparison with other effects. The yearly loss is estimated at $1,500,000 and the measure of damage at $12,500,000, both of which are excessive, and remedies may be readily applied. Lakeside population in the United States outside the Chicago district, and between Lake Superior and the international boundary is 3,053,614. The total population between Lake Superior and tidewater is 4,177,252. The expenditure by the United States for works outside the Chicago district and below the level of Lake Superior has been $76,562,717.93, out of a total of $106,205,935.64.

59. *The Argument* on the facts is set forth in Part II, and some leading points are referred to as follows:

(*d*) *The Waterway Policy of Illinois* comes down from the discovery of the Illinois country in 1673 and the ship canal project of Joliet in 1674. It had much early official sanction and it determined the boundaries of the new state in 1818. The Illinois and Michigan Canal was the first achievement and was immediately followed by efforts for a ship canal. The state policy finally expressed itself in the Sanitary District Act of 1889, the Constitutional Amendment of 1908, state ownership of water power and efforts for federal co-operation. The Chicago Sanitary and ship canal was diligently prosecuted without protest from any quarter, and was opened in

January, 1900. Its legal status was established in 1906, by the Supreme Court of the United States, on the basis of a natural outlet, under proper state and federal authority. The right to construct presumes the right to use.

(*e*) *The Probable Effect on Lake Levels* was considered and published prior to and during the construction of the work and no official observation and determination were entered upon until later. Material discrepancies in results appear and are undergoing revision from later data. The actual effects cannot be segregated and determined by direct observation, and the estimates thereof are inferences from "subtle expert analyses." The effect is subordinate and merged in the family of changes, both natural and artificial, and effects much greater and better defined have not been deemed worthy of correction. Meantime, the progressive deepening of channels many times exceeds the alleged effect. Any effect is so minor and so masked by major effects that it may be considered immaterial.

(*f*) *The Benefits* are many times the alleged damage, and any action in the nature of an injunction, if such were legally possible, would produce enormous loss and confusion in comparison to the extreme claim for damage. The damages are in the nature of minor interferences and inconveniences rather than prohibitory or confiscatory, and the doctrine of comity among utilities, as developed in the bridge cases, is applicable. The damage is without redress. Enjoyment in the new works will amply compensate for any injury occasioned.

(*g*) *A Remedy* may be readily applied to meet any effect due to the Chicago diversion, and under such circumstances no objection can lie to the taking of water for a public purpose. Such remedy is a proper part of present projects for channel improvement and is a necessity for the deeper channels predicated by the Davis lock, and for the better control of lake and river levels. The effects of the Chicago diversion have been many times off-set by the progressive deepening of channels and will be entirely masked in further deepening and better lake and river control. Responsibility for remedies rests in the United States.

60. *The Foreign Relations* are covered under Part III.

The Canadian Grievance does not differ in character from that in the United States, but is nominal above Niagara. Her chief population and commerce pertains to Lake Ontario and the Saint Lawrence where the effects are less and the commerce small in comparison to the upper lakes, and remedies are easily applied.

Treaties give Canada no redress. All the works complained of were fully established without protest and legally sanctioned prior to the treaty of 1910, which has been invoked in this case. Such treaty contains no reference to the subject-matter, and under the principles laid down in the Rio Grande case it could not operate to interfere with the sovereign right to develop any resource required for the public welfare or convenience. *Canada* is not on a footing with the other affected interests in the United States as she is not compensated by sharing the beneficial enjoyment. The policy recognized in former instruments, as, the right of navigation in Lake Michigan for terms of years, the right of navigation in the Mississippi by treaty of 1782, and the right of navigation in Illinois canals by the Act of 1872, needs little expansion to give Canada the beneficial use of the lakes and gulf waterway and this would richly compensate her for any alleged losses.

J. Conclusion.

61. *The Water Trail* from the Gulf of Saint Lawrence, thirty-three hundred miles by way of the Great Lakes to the Gulf of Mexico, guided exploration, led early trade and travel and determined dominion. Its betterment enlisted the concern of statesmen while permanent settlements were few and the Indian and the fur-trader dominated its hinterland, and the State of Illinois was fashioned in 1818 to develop the link which should perpetuate commercial and political union between the two great river basins. The first Saint Lawrence canal system proceeded on the basis of natural depths in lake outlets and the Illinois link was so promoted, but federal aid and her own resources proved insufficient for more than the Illinois and Michigan canal. Thus came to pass in 1848 an actual commercial highway from Gulf to Gulf. Canada again sought to exhaust the possibilities of lake navigation in 1871, by canals of twelve feet, later increased to fourteen feet, and this was all that the wise men of the lakes could then foresee, but the system was practically obsolete before completion in 1899. Meantime agitation continued in Illinois for a steamboat canal, and the shallow waterway advocates, official and otherwise, have not yet reached the depth of ten feet in the original conception.

The Sanitary Necessity of Chicago and the valley mobilized hereditary state policy to the achievement of a waterway which should exhaust the physical opportunity, discount the future need and quicken destiny, and already follow the Davis lock and the proposed new Welland for the like depth of twenty-four feet. The consideration of 1885-9 determined that sanitation should contribute to and become the incident of a deep waterway purpose. The constitutional amendment of 1908 determined that the incidental water power should likewise contribute. Perforce of circumstances land reclamation and municipalities add their quota. Illinois thus early formulated a policy of conservation which develops every collateral utility and pays largely the cost of the deep waterway from by-products. Her example is to be commended and emulated rather than disparaged.

The Gulf to Gulf Waterway, thirty-three hundred miles, can be developed for a depth of twenty-four feet for the cost of the Panama canal. The proportion of restricted channel will be small and vessels can be made that will navigate the same under their own power, as well as the lakes and the high seas, and carry cargoes of twenty-five thousand net tons. Without such waterway, the Panama canal may become not only a relative but a real injury to the continental interior.

The Hudson Bay Waterway following northward seventeen hundred miles along the continental thalweg, with a summit under one thousand feet in altitude, is only less feasible. Thus five thousand miles along the lowest levels, at less than five per cent. of railway capitalization, make the base lines for a related waterway system which comprehends all the waters of the continental valley from the gulf margin to the northern limit of soil production. As the rigors of climate close the northern outlet and later the eastern outlet, vessel movement retreats and always finds southern outlet even from the latitude of Lake Michigan.

Transportation is the dominant economic factor. Seventy per cent. of the commodities moved by rail cost more for transportation than for original production. Already, sections of the interior exceed in railway mileage densely populated European countries with a waterway system and a sea front. Such mileage is ample for local convenience, and for passenger, express and high class freight traffic, which yield a better return. Rail tariffs on fuels, building material and raw material for manufactures, blight industry and deny development of the coarser resources. A part of the capital required to provide the extra mileage which cannot solve the real economic problem, can provide the waterway development which will. The interior cannot maintain a competitive basis with lands better favored with cheap transportation, and it will chinaize as the cream is skimmed.

The Major Resource and capacity for population are in the valley and remote from any seaboard. Nature has constructed no barriers by which to segregate nationalities, and there is no race diversity.

Not elsewhere has a single estate so great been laid out for a homeogeneous people. Physical unity dictates economic unity, and even political unity if artificial boundaries interfere.

The Illinois Relation is shown by the water systems and the connecting passes through the highlands. She is the focus from which diverge the three sea outlets, south, east and north, and toward which converge great tributaries. She is the natural pioneer in policies of waterway development and conservation, for she is alike interested in every direction, while her neighbors have sectional preferences. Already interests between the Lakes and the Gulf are united and mobilized for the southern outlet and their program combines waterways and conservation so as to develop every utility. It is time that a like unity and program should prevail along the Saint Lawrence route without regard to boundary lines. Statesmanship should be broad enough to make the best application of every resource, and every interest should be wise enough to see destiny in the dreams of the explorers.

LYMAN E. COOLEY.

APPENDIX NO. 1.

Statement on Behalf of The City of Chicago.

(Filed in the office of the Secretary of War and the Chief of Engineers, U. S. A., Washington, D. C., March 30, 1912.)

Printed in report of hearings before the Committee on Commerce, U. S. Senate, April 16, 1912, on "Deep Waterway from the Great Lakes to the Gulf."

To the Secretary of War,
Hon. Henry L. Stimson, and
Chief of Engineers, U. S. Army,
Brigadier General W. H. Bixby.

GENTLEMEN:

On the application of the Sanitary District of Chicago, for a permit to increase the flow into its main channel or outlet by way of the Chicago River and other feeders, and in the hearings relating thereto, the City of Chicago has been represented by the Commissioner of Public Works, Hon. Lawrence E. McGann, acting for the mayor, and by Aldermen Charles E. Reading, L. D. Sitts, W. F. Ryan, and John S. Derpa, acting for the city council, and by their consulting engineer, Lyman E. Cooley.

The City of Chicago has been and is co-operating with the Sanitary District and supporting its contentions, and it has the most vital concern in the issues before you. The consideration of the subject matter has taken a very wide range and raised many questions, all of which could not be anticipated, and the city feels that it should submit a brief in its own behalf which would go fully into the merits of the questions involved. But it seems that time cannot be allowed for this purpose. The representatives of the city therefore feel constrained to limit themselves to a statement which shall recite concisely the history of the matter, the position of the city, and re-enforce the position of the Sanitary District of Chicago, and the undersigned has been authorized and directed to prepare and submit such statement.

1. *The Sanitary project* was matured by the City of Chicago in the years 1885-9 at a cost of about $100,000, under the advice of engineering and legal experts and with the co-operation of the State Board of Health of Illinois and a joint committee of the General Assembly. The City promoted the Sanitary District Act in force July 1, 1889, and continued its oversight until the Sanitary District was adopted by the people and actually organized early in 1890. The purpose was to provide a main channel or outlet with necessary adjuncts by which the City, together with other municipalities within the corporate limits of the District, could dispose their sewage under certain conditions as laid down in the Organic Law. Since its organization the confines of the Sanitary District have been enlarged and the City of Chicago through annexation has absorbed in large part the urban population and now contains 94.5 per cent. of the population of the Sanitary District.

The City of Chicago is endowed with full municipal functions as a part of the political system of the state and could have undertaken the complete solution of the sanitary problem had it possessed the proper territorial limits and the necessary financial resources. The Sanitary District was therefore created for a limited and specific purpose. The City therefore views with the gravest concern any proposition or action which tends to limit or disbar any function or power of the Sanitary District because the burden will thus be shifted in greater or less degree, or wholly, back upon the City, with extraordinary complication and cost beyond the power of the City to meet.

The entire policy of the City and its environs for the past twenty-five years in respect to the sewage system, the park system, the harbor and waterway development and all collateral work, has shaped itself in conformity with the sanitary and ship canal project, and any attempt to change policies and conditions at this time will result in the utmost confusion and cannot be seriously entertained or admitted by our people.

2. *The Sanitary and Ship Canal of Chicago* was actually constructed across the Chicago Divide between the waters of the Chicago River at Robey street and the Desplaines River at Lockport, with a flowing capacity of 840,000 cubic feet of water per minute, or 14,000 cubic feet per second in round numbers at low water of 1847 in Lake Michigan. A small portion of this channel in the clay between Robey street and Summit was constructed with a preliminary capacity of more than 500,000 cubic feet of water per minute, and under the law is subject to progressive development with the growth of popu-

lation and also to complete development within one year after the General Government shall co-operate in the production of a through waterway. The cost of such development is relatively a small item. The channel was actually opened January 17, 1900, in compliance with Section 27 of the Organic Law and no change affecting the capacity thereof has since been made.

The City of Chicago does not admit any doubt as to the full right and power of the State of Illinois to authorize the particular solution and the method of applying it as outlined in the Organic Law, and attention is called to the decision of the U. S. Supreme Court in 1906, in the case of the *State of Missouri* v. *the State of Illinois and the Sanitary District of Chicago,* where the whole subject matter was entered into and affirmatively decided. It is not now competent to raise questions as to the manner of the solution nor in regard to the right to take water to the extent of the capacity of the main channel or outlet, or 14,000 cubic feet of water per second at low water of Lake Michigan.

Under the authority of the State, the Sanitary District proceeded diligently and completed its channel as above stated, and had actually notified the Governor of that fact, before the end of the year 1898, and several months prior to the Act of Congress of March 3, 1899, Section 10 of which has been assumed to give jurisdiction in the premises. The permit issued by the Secretary of War and the Chief of Engineers, U. S. Army, May 8, 1899, does not bear out any such presumption, but is conditioned solely by the capacity of the Chicago River. In no event could the Act cited have a retroactive effect.

The right of the United States to conserve the highways of commerce and the easements which it has developed is not questioned, and we assume that the right to take water cannot be exercised in a wilful and frivolous manner and so as to create unnecessary hardship to other interests, and therefore we admit a certain degree of supervision as to the manner in which the water shall be taken. The law of the State of Illinois also states that public waters shall not be entered upon and utilized in such manner as to unduly interfere with their uses for navigation.

In addition to the foregoing Chicago claims a right to 1,000 cubic feet per second by way of the Illinois and Michigan Canal and that such right is both proscriptive and by authority of law.

In view of circumstances already stated the City is unable to develop properly and fully its contentions respecting the foregoing and it expressly reserves its rights in case they are not admitted.

3. *The expenditures* by the Sanitary District of Chicago from its organization down to January 1, 1912, have been	$68,524,491.16
The expenditures by the City of Chicago for its intercepting sewer system along the Lake front of the City have been	6,706,804.37
The total is	$75,231,295.53

The same ratio of expenditure extended over the United States would represent about $3,000,000,000, or several times the amount expended by the United States upon its river and harbor system.

The further amounts that must be expended in developing and completing the program will bring the total well above $100,000,000. In addition the park boards have expended large sums and will expend still larger sums in parkways along the City front, which serve to protect the water supply of the city and to transfer the filth producing industries to the back lots. It is further recognized that the large sums required for harbor and waterway development must conform to the adopted program.

4. *The waterway policy* of the State of Illinois has been established from the beginning. The Sanitary District Act was intended by its promoters as primarily a health provision and an important consideration in its passage was that the same waters that performed the service for Chicago would perform a like service for all the urban population contiguous to the Desplaines and Illinois Rivers. A secondary motive was the contribution which would thus be made to the waterway policy of the state; and the state took good care that these provisions of law should be fully set forth. And from the standpoint of the state the Sanitary District Act is a waterway act in which Chicago is allowed certain rights of sewage disposal, in consideration of its investment. The state further defines its position by contemporaneous act and joint resolution and has since adopted a constitutional amendment by which the General Assembly is authorized to expend $20,000,000 between the end of the drainage canal and the head of the lower Illinois River at Utica for waterway development and incidental water power. The state policy in this respect is based on the full capacity of the drainage canal or 14,000 cubic feet

plus the capacity of the Illinois and Michigan Canal, or 1,000 feet, a total of 15,000 feet. The state recognized that a large volume of water will enable the production of a deep waterway not less than 14 feet, as stated in the joint resolutions of 1889 and 1897, and it is further recognized in the report of 1907, that the larger volume for which the Sanitary Canal was actually constructed will enable a still greater depth through the lower Illinois River.

5. *The Association of Drainage and Levee Districts* of the State of Illinois represents the lands subject to reclamation in the lower Illinois Valley, some 400,000 acres, and it recognizes the necessity for a deep and capacious channel, with a large and permanent water supply therein for the stability and maintenance of the lower Illinois River as well as for the sanitary welfare of the valley; and they are promoting the removal of the dams in this portion of the river and the development of such channel by dredging in conjunction with the water supply from Lake Michigan for the threefold object of drainage, sanitation and deep navigation.

The Lakes-to-the-Gulf Deep Waterway Association represents all interests in the several states bordering the route between Lake Michigan and the Gulf of Mexico, and this association has adopted a policy as set forth in its last two conventions, 1910 and 1911, for a waterway with a preliminary depth of 14 feet with all structures and rock cuts adapted to an ultimate depth of 24 feet, and the large water supply provided for by the State of Illinois is necessary to the carrying out of such a policy.

6. *The water power development* by the Sanitary

District and by the State of Illinois comes strictly under the rules laid down by the U. S. Supreme Court in the Montello case. The Supreme Court of Illinois held in the case of the suit to test the validity of the Sanitary District Act, in June, 1900, that it would be unreasonable to deny the right to develop water power which was created by other and necessary work, and called attention to the fact that the burden of taxation might thus be mitigated. Under the project of the Deep Waterway Association eighty per cent. of the fall between Lake Michigan and the Mississippi River at Cairo, may be converted into water power and this amounts to about half of what the same water would produce if utilized for the same purpose in the direction of the St. Lawrence, and not one-fourth as has been stated.*

There can be no objection to the development of such power under public ownership as proposed, and as the incident of other and necessary uses of the water for sanitary and deep waterway purposes. It is a circumstance not to be overlooked that the waters diverted are to be put to all of the three uses recognized in their order in the recent treaty respecting the boundary waters between the United States and Canada, to-wit: domestic and sanitary, waterway, and water power. These uses are not alternative but cumulative, and they combine in a justification superior to any separate and distinctive reason.

7. *The population of the Sanitary District,* by the

***NOTE:** This statement is based on complete development and full utilization by means of dams. Reserving the scenic attractions of Niagara River under the Treaty of 1909 and employing the usual methods of development, the statement in Topic 51 is also true.

Federal Census of 1910 was 2,311,810. The contiguous population within ten miles of the water route between the Sanitary District and the Mississippi River was 445,828. The total population in the District and in the Valley immediately concerned in the sanitary problem and also in the deep waterway was 2,757,638. Of this population 2,468,450 were urban or in communities of 2,500 people and upwards. The aggregate represents 49 per cent. of the total population of the state and 71 per cent. of the urban population.

The aggregate population in cities of 25,000 and upwards about the Great Lakes above Niagara in 1910 was 2,325,543, or less than the urban population of the Sanitary District and adjacent to the water route in the State of Illinois. The statistics for the minor cities are not yet available and these would increase the aggregate for the Lakes. And again, we should add the urban population on the Canadian side, for which the data are not in hand. The total, however, would not greatly exceed the figures given for Illinois. There are other populations in the United States and Canada below Niagara which claim to be affected by the diversion of waters and again there are other populations in the United States below the mouth of the Illinois which are benefited thereby.

It may be said, therefore, that a population nearly if not substantially equal to that outside of Chicago and bordering the Great Lakes above Niagara have an identical interest in the maintenance of all conditions which favor navigation. It may be said further that such population have a deep and immediate concern in the development of a deep waterway through the State of Illinois and onward to the Gulf of Mexico, and that that deep interest should in truth extend to all the population about the Great Lakes and differ only perhaps in degree. In addition to the above this half of the total has a paramount interest in its life and health, which should be generously recognized by the other half even though minor damage and inconvenience be inflicted. If it is shown later that no actual harm or inconvenience is necessary, then most certainly there can be no valid ground for objection, in view of the tremendous potentialities involved in the diverted water.

8. *The effect on lake levels* and the damage caused thereby is likely to be over-estimated. Causes affecting lake levels are many and show up in continual oscillation, sometimes through a considerable range, and in changes of general level with the seasons in the years, and through a cycle of years. There are no fixed rules to govern the variable effects due to difference in rainfall, vegetal cover, run-off and evaporation, and the individual and collective effects are so incapable of precise definition that it is impossible to deduce a remainder which could be assigned to an unknown cause. The fact of a diversion and the amount thereof would be discoverable only in the new outlet itself, and the valuation of the effects thereof would be purely a deduction from physical data and not a subject of direct observation. Whatever the effect may be, by such amount is lowered the general horizon of oscillation and change. Owing to the variations vessels cannot utilize the

depth with the same degree of certainty as though a fixed and invariable plane prevailed, and it may be questioned whether a proper rule of damage can be based on the theory of a change in such plane. In other words, is it not attempted to apply the precision of the rifle to a shot gun problem?

It is to be noted that the natural depths at characteristic localities in the intermediate channels of the Lakes were originally from ten to twelve feet and that these depths were increased at various times until a general depth of sixteen feet prevailed, and that between the years 1891 and 1895-6 these channels were deepened by four to five feet and greatly enlarged, and that coincident with the completion of these deeper channels we have the characteristic low water period. It is to be noted further that following the high water of 1886 there has been almost a continuous deficiency in rainfall, amounting to six feet more or less at various lake stations, and this coupled with accentuation of evaporation has produced profound results. It is to be noted also that the Board of Engineers on Deep Waterways, in its report of 1900, recognizes a permanent lowering of Lakes Michigan and Huron by nearly one foot, through a change in the outlet at Port Huron. It may be said further that the report of the International Waterways Commission for 1910 calls attention to the fact that the level of Lake Superior was unwittingly controlled for a number of years by the works of the International Bridge and of the water power companies at Sault Ste. Marie, with consequent influences on the levels of the Lakes below, and this fact, though the effects were comparable with those assigned to the Chicago Drainage Canal, seems to have attracted no attention. These several and superior effects seem to have aroused no excitement among vessel interests, nor have they led to any propositions for remedying the same. It is therefore not quite understandable why such supreme importance is attached to the minor effects produced by the diversion at Chicago. The report of the First International Waterways Commission, 1896 (American section, known as "United States Deep Waterways Commission"), gives all obtainable information respecting Lake levels prior to 1860, and it appears that the highest water known occurred in 1838, and that the lowest water known occurred nineteen years previously, in 1819-20, and that such low water was from eight inches to one foot lower than the low water of 1895-6. It appears, therefore, that the extreme fluctuation of the Lake surface took place within a period of nineteen years, and before inhabitation had changed conditions in the watershed, and before Lake channels had been disturbed. The range of fluctuation in Lake Michigan was between six and seven feet.

Had the Chicago diversion begun in 1895-6, contemporaneously with the opening of the deeper intermediate channels and the Poe Lock at the Soo, and when the Lake fleet had not developed to these greater depths, it could not have been said that navigation interests were damaged by reason of the fact that the unutilized depths had been diminished by a number of inches. On the contrary it is known that great loss in vessel property took place as soon as the larger depths were utilized by the greater carriers, and that such damages were without redress because what had been done was in the interest of the common welfare. The new lock at the Soo authorized some time since and now under construction is to have a depth of 24½ feet, the same as that of the Drainage Canal, or several feet in excess of existing channels, and the policy of producing channels which shall equal such lock depth is already established. In view of this project actually in sight and in process of consummation, is it to be said that vessel interests will be damaged by a diminution in depth not yet utilized and for which no vessel exists? In the progressive deepening of lake channels and that of the harbors which must follow is not the effect of diversion substantially met, and, if not, does it involve more than a nominal increase in cost to meet the deficiency due to such cause?

9. *A minor damage or inconvenience* may be without redress under the doctrine of "comity among utilities," but that is no sufficient reason for denying the appropriation of public waters to beneficial use when and where the benefits are manifold and contribute in an extraordinary degree to the public welfare. The Report of the International Waterways Commission, on the Chicago Drainage Canal, 1907, estimates the damage to be occasioned by the diversion of 10,000 cubic feet per second and the consequent lowering of the Lakes by six inches at $1,500,000 per annum, in round numbers. On the other hand, the value from the bettered sanitary condition at Chicago and in the Illinois Valley cannot be estimated in figures; the value of the water highway that

is to be produced with the aid of this diverted water is comparable with that of the Great Lakes; the reclamation of the overflow lands of the Illinois Valley is facilitated, and this represents a very large sum; water powers are created under public ownership, and this represents another large contribution to wealth; and again fisheries develop through the greater volume and the enrichment of the waters.

In the ten years between 1896 and 1906, the fisheries of the Illinois River increased from a catch of about 8,000,000 pounds to 22,000,000 pounds and the stream was second to the Columbia where in fact the fish are the product of the sea. The value of these fish on the shores of the waters was over $770,000, or $11 per acre for all the water space in the Illinois Valley, and this value was doubled by the time the fish reached the consumer or exceeded $1,500,000, and will grow exceedingly with the fuller development of the Chicago program. In other words, the value of the annual fish crop which has come to pass through the carrying out of this enterprise exceeds all the damage which it is claimed has been occasioned to the shipping interests on the Great Lakes.

10. *A remedy that may be applied* so as to conserve the actual uses of water now made and avoid all damage is a complete answer to any objection to the taking of any volume of water that can be applied to other beneficial uses. No one will contend that waters cannot be appropriated if other and prior appropriations and dedications are not unduly interfered with.

The International Waterways Commission has examined a number of remedies, one of which is that of deepening channels and harbors by one foot at a cost of $12,500,000, which would allow the taking of 20,000 cubic feet of water per second, or a third more than the capacity provided for in the channels at Chicago. It is submitted that this cost would be still less if the deepening is a part of the program for deeper channels and harbors now initiated by the construction of the new lock at the Soo.

The International Waterways Commission, in its report for 1910, suggests a remedy which it regards as better and sufficient by means of compensation work. It is now engaged in working out the problems connected therewith, and is to report thereon before closing its labor.

It is unnecessary to multiply instances or advance suggestions. Congress has authorized examinations and reports respecting the better control of Lake levels and has also authorized examinations and reports based on the theory of utilizing waters diverted from Lake Michigan.

The State of Illinois directly and through its agencies has made a very large expenditure and is prepared to make other very large expenditures, the effect of which will be to produce a great waterway, which will pass to the control of the General Government, under all state laws thus far made and proposed, and the United States will thus be relieved of cost many times exceeding the cost of any remedies that may be required on account of diverted waters. It is felt, therefore, that the United States should raise no question of liability as against the

State of Illinois and its agencies on matters beyond their jurisdiction.

11. *The international question* and the bearing thereon of the Treaty of 1909 respecting boundary waters between the United States and Canada will not be entered into at this time. Attention, however, is called to an opinion furnished to the State Department by the Attorney General, Judson Harmon (see Opinions of Attorney Generals, 1895-7), in regard to a boundary water of the United States and Mexico, the Rio Grande del Norte, the navigation of which is expressly guarded by specific terms in the Treaty of Guadaloupe Hidalgo, between the United States and Mexico. In this case the waters of the stream were consumed in the development of the State of Colorado and the Territory of New Mexico, and in the opinion the rules of international law applicable in such cases are fully set forth.

It appears that the right of the people of a state to develop their resources and opportunities is fundamental, and that the United States cannot qualify by treaty sovereign rights not possessed by it.

12. *In conclusion* it may be recapitulated:

(*a*) Under proper and sufficient authority, physically expressed in adequate channels actually constructed and in existence, the right is established to take 15,000 cubic feet of water per second from the Chicago River by way of the main drainage channel or outlet and by way of the Illinois and Michigan Canal.

(*b*) The Secretary of War and Chief of Engineers, U. S. A., may not impair this right, but shall regulate the manner of taking so that no undue injury shall occur to the navigable channels through which such waters shall pass, as heretofore construed in permits.

(*c*) Independent of the questions referred to above under (*a*) and (*b*) the right to take the water should not be questioned in view of the enormous expenditures already made, the policies established and the expenditures predicated thereon, and in view of great and manifold benefits as contrasted to minor damage and inconvenience.

(*d*) Such minor damage as may occur is not irreparable and may be remedied at comparatively small cost, and the taking of waters for beneficial uses under such circumstances is not a subject for objection.

(*e*) The remedy, if any, is not within the jurisdiction of the State of Illinois and should be applied by the United States in view of the tremendous contribution of the State of Illinois and its agencies to a waterway of national and international importance.

(*f*) All the points herein referred to can be set forth and established in a brief in full which the time available has not permitted.

On behalf of and for the City of Chicago.

(Signed) LYMAN E. COOLEY.

WASHINGTON, D. C., March 29, 1912.

Filed March 30, 1:30 P. M.

APPENDIX NO. 2.

Relating to the application of the Sanitary District of Chicago for a permit to divert 10,000 cubic feet of water per second from Lake Michigan:

(a) Application.
(b) Decision of Secretary of War.
(c) Report of the Consulting Engineer and Attorney for the Sanitary District.
(d) The Chicago River Permit.

(*a*) *Application:*

THE SANITARY DISTRICT OF CHICAGO.

CHICAGO, February 5th, 1912.

SIR: On behalf of the Board of Trustees of The Sanitary District of Chicago, I have the honour to apply for enlargement of the terms of an instrument executed by the Secretary of War, May 8, 1899, as modified by instruments similarly executed on December 5, 1901, and June 30, 1910, respectively, in the following particulars and in view of the facts hereinafter set forth, to-wit:

The flow of water from Lake Michigan through the canal of The Sanitary District of Chicago is now limited by the said instruments to 4,167 cubic feet per second.

The population of the Sanitary District, the sewage of which is to be disposed of through the channels constructed and to be constructed by the said District, exceeds 2,500,000 persons, and is rapidly increasing. The only method at present available for disposing of the sewage of this population is by diluting the same with water withdrawn from lake Michigan and flowing through the Chicago Drainage canal. The least amount of water necessary to render sewage innocuous by the dilution method has been estimated by well recognized sanitary experts as 1,000 feet per second for every 300,000 inhabitants; so that the amount permitted to be withdrawn by the instruments to which reference has been made is much below the amount at present needed by the District.

The Sanitary District has been for some time engaged in investigating methods and devising plans for the treatment of the sewage with a view to requiring less water for its safe dilution in the future. The methods of other states and countries for such treatment of sewage are not as yet entirely satisfactory to all concerned, and any changes of methods for large cities must necessarily require several years.

Until these experiments are concluded and proper works installed, the use of additional water from lake Michigan is essential to the health of the large population of the City of Chicago and of the Sanitary District and of those who live adjacent to the Desplaines and Illinois rivers, into which such waters are discharged.

Subject therefore to such restrictions as to you may seem proper for the protection of the public interest, and to such a method of supervision as you may suggest to promote the general welfare, and pending the completion of the investigations now being conducted to render the use of increasing quantities of water in the future unnecessary, I have the honour to apply for permission for The Sanitary District of Chicago to withdraw from lake Michigan through the Chicago river and Calumet river—not to exceed 10,000 cubic feet of water per second; such permission to be revocable at any time by The Secretary of War, and subject to such action as the Congress of the United States may see fit to take in the premises.

Respectfully submitted,

George M. Wisner,
Chief Engineer.

Hon. Henry L. Stimson,
Secretary of War,
Washington, D. C.

(*b*) *Decision of the Secretary of War:*

In the Matter of the Application of the Trustees of the Sanitary District of Chicago for Permission to Divert From Lake Michigan 10,000 Cubic Feet of Water Per Second.

War Department,

Washington, Jan. 8, 1913.

The Sanitary District of Chicago applies to the War Department for permission to increase the amount of water it is authorized to withdraw from Lake Michigan from 4,167 cubic feet per second, the amount now authorized, to 10,000 cubic feet per second.

The Chicago Drainage Canal was opened in January, 1900. It reverses the flow of the Chicago River, which formerly emptied into Lake Michigan, and as a result a portion of the waters of that lake, instead of following their former course through Lakes Huron, Erie and Ontario into the St. Lawrence, are now carried across the watershed into the Illinois River, and through that to the Mississippi and the Gulf of Mexico. The canal thus serves as a system of drainage for the city of Chicago, carrying the sewage of that city southward to the Mississippi, and thus protects the water supply of that city, which is taken from Lake Michigan.

Permission to divert water from Lake Michigan was first granted by my predecessor, Secretary Alger, on May 8, 1899. He permitted a flowage of 5,000 cubic feet per second, but his permit contained the following conditions:

1. That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the Sanitary District of Chicago to Congress for consideration and final action, and that this permit shall be subject to such action as may be taken by Congress.

2. That if, at any time, it becomes apparent that the current created by such drainage works in the south and main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its south branch.

Subsequently, during the administration of Secretary Root, the amount of the current permitted to be taken was modified or restricted until December 5, 1901, when it was fixed at the amount now permitted, and these permits contained the condition—

That the permission herein given shall be subject to such modifications as in the opinion of the Secretary of War the public interests may from time to time require.

On March 14, 1907, an application made for permission to divert an additional 4,000 cubic feet per second for the purpose of reversing the current of the Calumet River and flowing that river also through the canal to drain the southern portion of Chicago was denied by Secretary Taft in an opinion in which he referred once more to the desirability of submitting "this question of capital and national importance to the Congress of the United States."

It is clear that even under the conditions heretofore manifested on these applications, the proposition to divert the waters of Lake Michigan into another watershed has not been entertained without hesitation and careful restriction by my predecessors. The propriety of obtaining congressional sanction for the project has been pointed out from the beginning; and the form in which the permit has been granted, even for the moderate amount of diversion permitted, has been so phrased as to indicate that the permission was predicated upon the absence of any substantial injury to commerce.

The sanitary canal has never received the direct sanction of Congress. It was built solely under the authority of the State of Illinois, as given in its 1889 general act for creating sanitary districts. And although pursuant to the suggestion of my predecessors the question of the propriety of its diversion of water from Lake Michigan was presented urgently in the reports of the Chief of Engineers for the years 1899 and 1900 as transmitted to Congress, no action upon the question has ever been taken by that body. In the argument before me it was urged that the present canal represented the growth and development of a national policy expressed in two acts of Congress, 1822 and 1827, which authorized the construction of a canal "to connect the Illinois River with Lake Michigan," thus connecting the two watersheds. (Acts of March 30, 1822, and March 2, 1827.) But these statutes authorized a canal for the purpose of navigation and not sanitation. (*Missouri* v. *Illinois*, 200 U. S., 526.) The Illinois and Michigan Canal, actually constructed under their authority, derived its water for navigation purposes from the Calumet, Desplaines and Chicago Rivers, and not from the Lakes. And although in the latter part of its existence it was used to a very slight extent to help purify the waters of the Chicago River and thus sanitate the city of Chicago, such a purpose could not have been dreamed of at the time its construction was authorized by Congress, ninety years ago. I can not see that its authorization and construction offer the slightest congressional sanction for the great canal now under discussion, which was not even contemplated until much more than half a century later. Even at the time when the present canal was constructed and opened it is very evident that its ultimate possible effect upon the navigation of the Great Lakes was not clearly realized by those interested in that navigation. The evidence before me indicates that the withdrawal of water from Lake Michigan at Chicago would require about five years to produce its full effect upon the levels of the Great Lakes (see report of International Waterways Commission on Chicago Drainage Canal, p. 7), and that this effect would be still further obscured by periodic oscillations in the lake levels. These facts may easily explain any inaction on the part of the Nation and their representatives to this withdrawal of water and make it clear that any argument of implied acquiescence must be scrutinized with unusual care.

In this respect the situation is now very different. The present application was opposed by representatives of twenty-three cities and six states interested in harbors and commerce upon the Great Lakes, notably the cities of Duluth, Milwaukee, Toledo, Cleveland and Buffalo. It was opposed by representatives of the navigation interests engaged on the Chicago River as well as on the Great Lakes, and by the official representatives of the Canadian Government as well as private Canadian interests engaged in the navigation of the Lakes and the St. Lawrence River, including representatives of the cities of Kingston and Montreal.

A very careful consideration of the voluminous evidence and statements submitted, as well as a consideration of the reports of other commissions and boards of engineers who have investigated the subject, leaves no doubt in my mind that the withdrawal of 10,000 cubic feet per second would substantially interfere with the navigable capacity of the Great Lakes and their connecting rivers. The Chief of Engineers, whose statutory authority in passing upon this application is concurrent with and independent of my own, and whose opinion upon such a question of scientific conclusion must be given especial weight, so states in his recommendation. His conclusions are corroborated by the authority of other boards of investigation, notably the report of the International Waterways Commission of January 4, 1907.

Careful observations and calculations conducted under the offices of the United States Lake Survey and reported through the Chief of Engineers, covering observations for the last forty-six years, indicate that a withdrawal of 10,000 cubic feet per second would reduce levels at various places as follows:

	Inches.
Lakes Huron and Michigan	6.9
Lake St. Clair	6.3
Lake Erie	5.4
Lake Ontario	4.5
St. Lawrence River at Rapide Plat	4.8+

The foregoing effects would be produced at mean lake levels; the lowering effects would be much greater at low-water periods—

the precise time when any additional shortage would be most keenly felt. This reduction would create substantial injury in all of the American harbors of the Great Lakes and in the St. Marys, St. Clair, and Detroit Rivers. It would produce equal injury in Canadian harbors on the Great Lakes, and a still greater injury on the lower St. Lawrence, the Canadian officials claiming a probable lowering effect of twelve inches at Montreal at low water.

The United States has improved about 106 harbors and rivers on the Great Lakes affected by this diversion and has spent on such improvements over $90,000,000. The Canadian Government has improved over fifty harbors on Georgian Bay and Lakes Huron, St. Clair, Erie, and Ontario. By treaty, American vessels are accorded equal rights of navigation with Canadian vessels in all these waters, including the St. Lawrence River. The reduction of the water in these harbors and channels would diminish to just that extent the amount of these improvements, and would nullify to just that extent the effects of the moneys which have been appropriated for that purpose by the respective governments. Connecting various portions of these waterways are the two canals at the Sault Ste. Marie, the Welland Canal, and a number of canals on the St. Lawrence River. The available depth of water over one or all sills of each of these canals would be affected, and in some cases reconstruction might even be made necessary.

The enormous lake traffic which uses these harbors and these rivers is increasing with great rapidity, both in gross volume and in the size and average draft of the vessels employed therein. The Chief of Engineers reports that to lower the water surface six inches would reduce the permissible load of one of the large modern vessels by from 300 to 550 tons, with a consequent loss of from $3,600 to $7,500 in freights for such vessel per season. The International Waterways Commission reported that it would be a conservative estimate which would make the loss to the navigation interests resulting from a reduction of six inches in the depth of water as $1,500,000 per annum, or a sum which, capitalized at 4 per cent., would amount to a loss of $37,500,000 (see third progress report of International Waterways Commission of December 1, 1907, p. 24). The lowest careful estimate of injury to American vessels alone is reported by the Chief of Engineers as $1,000,000 per year.

The argument was made before me that, owing to the well-known fact that the levels of the lake vary, owing to winds and change of barometric pressure, by amounts even greater than the reduction which would be caused by this canal, therefore the proposed reduction is of no consequence. This argument is well disposed of in the report of the International Waterways Commission of January 4, 1907, on page 8, as follows:

> It is evident that the average level of the lake may be lowered considerably without the change becoming immediately apparent, and the fact has been used as an argument to prove that the lowering caused by the Chicago Drainage Canal is of no consequence to those interested in navigation. Since they can not see it they will not know it and will not feel it. The argument is fallacious. It is true that they can not see it immediately, but they will soon feel it and will know it through the most costly means of acquiring knowledge—the injury to their material interests. The oscillations will remain the same as before, but low water will fall lower and high water will rise less high. The average draft of vessels must be diminished by the amount that the average level is lowered unless the depth be restored by remedial works.

In a word, every drop of water taken out of Chicago necessarily tends to nullify costly improvements made under direct authority of Congress throughout the Great Lakes, and a withdrawal of the amount now applied for would nullify such expenditures to the amount of many millions of dollars, as well as inflict an even greater loss upon the navigation interests using such waters.

On the other hand, the demand for the diversion of this water at Chicago is based solely upon the needs of that city for sanitation. There is involved in this case no issue of conflicting claims of navigation. The Chief of Engineers reports that so far as the interests of navigation alone are concerned, even if we should eventually construct a deep waterway from the Great Lakes to the Mississippi over the route of the sanitary canal, the maximum amount of water to be diverted from Lake Michigan need actually be not over 1,000 feet per second, or less than a quarter of the amount already being used for sanitary purposes in the canal. This estimate is confirmed by the report of the special board of engineers on the deep waterway from Lockport, Ill., to the mouth of the Illinois River, dated January 23, 1911. It is also confirmed by the practical experience of the great Manchester Ship Canal in England. From the standpoint of navigation alone in such a waterway too great a diversion of water would be a distinct injury rather than a benefit. It would increase the velocity of the current and increase the danger of overflow and damage to adjacent lands.

We have, therefore, presented in this case claims of entirely different characters and jurisdictions—the claim of sanitation on the one side and of navigation on the other; the vital interest of a single community on the one side and the broad interest of the commerce of the nation on the other. The discretion given to the Secretary of War under Sections 9 and 10 of the act of 1899 is very broad, but I have very grave doubts as to whether it was intended to authorize him to grant a permit which would inflict a substantial injury upon commerce in order to benefit sanitation. The entire purpose and scope of that legislation was to make him the guardian of the commercial interests of the nation represented in their waterways. And while he sometimes under that statute must decide that the interests of one class of transportation are less important and must yield to the conflicting interests of another class, I have considerable doubt whether it was intended to give him authority to sacrifice substantial interests of navigation to entirely different claims over which he normally has no jurisdiction whatever.

But however that may be, and without resting my decision upon the question of my legal authority, I am quite clear as a matter of discretion that under the facts presented by this case no further diversion of water should be permitted at Chicago without the direct sanction of the Congress of the United States. I do not for one moment minimize the importance of preserving the health of the great city of Chicago; but when a method of doing this is proposed which will materially injure a most important class of the commerce of the nation and which will also seriously affect the interests of a foreign power, it should not be done without the deliberate consideration and authority of the representatives of the entire nation. The growth of Chicago is phenomenal and its representatives are quite unwilling to put any final limit to the demand which may be made upon the waters of Lake Michigan for its sanitation under the system now in use. I have before me the report in 1911 of the president of the sanitary district, in which he says:

> I am of the opinion that the presumption that our water supply is to be limited to 10,000 cubic feet per second, or 600,000 cubic feet per minute, is gratuitous and mischievous and should not be voiced by the officials of this district. I believe that we should have the volume requisite to our needs as they appear and are justified.

It is therefore quite conceivable that compliance with their sanitary needs according to this method of sanitation may eventually materially change this great natural watercourse now existing through the lakes. The weighing of the sanitation and possibly the health of one locality over against the commerce of the rest of the Nation and the consideration of our relations and obligations to Canada in respect to a great international waterway are not matters of mere technical or scientific deduction. They are broad questions of national policy. They are quite different in character, for example, from the question of fixing the proper location of a pierhead line or the height or width of a drawbridge over a navigable stream—fair samples of the class of questions which come to the Secretary of War for decision under the above-mentioned act of 1899. While the researches and opinions of experts in the respective fields are necessary and useful as an assistance toward reaching a fair and proper policy, the final determination of that policy should belong not to an administrative officer but rather to those bodies to whom we are accustomed to entrust the making of our laws and treaties.

In my view of the proper exercise of my discretion in this matter the foregoing considerations are sufficient for a decision of this case. Having reached the conclusion that the proposed diversion of the waters of Lake Michigan would substantially injure the interests of navigation on the Great Lakes which it is my legal duty to protect, it would clearly follow that the present application should be denied.

I have carefully examined, however, the evidence which both sides have introduced bearing upon the sanitary needs of the city of Chicago, and my conclusion is in no way shaken. I am not persuaded that the amount of water applied for is necessary to a proper sanitation of the city of Chicago. The evidence indicates that at bottom the issue comes down to the question of cost. Other adequate systems of sewage disposal are possible and are in use throughout the world. The problem that confronts Chicago is not different in kind but simply larger and more pressing than that which confronts all of the other cities on the Great Lakes, in which nearly 3,000,000 people of this country are living. The urban population of those cities, like that of Chicago, is rapidly increasing, and a method of disposition of their sewage which will not injure the potable character of the water of the Lakes must sooner or later be found for them all. The evidence before me satisfies me that it would be possible in one of several ways to at least so purify the sewage of Chicago as to require very much less water for its dilution than is now required by it in its unpurified condition. A recent report of the engineer of the sanitary commission (October 12, 1911) proposes eventually to use some such method, but proposes to postpone its installation for a number of years to come, relying upon the present more wasteful method in the meanwhile. It is manifest that so long as the city is permitted to increase the amount of water which it may take from the Lakes, there will be a very strong temptation placed upon it to postpone a more scientific and possibly more expensive method of disposing of its sewage. This is particularly true in view of the fact that by so doing it may still further diminish its expenses by utilizing the water diverted from the Lakes for water power at Lockport. But it must be remembered that for every unit of horsepower realized by this water at Lockport four units of similar horsepower would be produced at Niagara, where the natural conditions are so much more favorable. Without, therefore, going more into detail in a discussion of this question, I feel clear that no such case of necessity has been presented by the evidence before me as would justify the proposed injury to the many varied interests in the great waterways of our lakes and their appurtenant rivers.

It remains only to consider certain special arguments that have been pressed upon me. It has been urged that the levels of the lakes, even if lowered, could be restored by compensating works. To a certain extent that is true. But the very nature of this consideration offers another illustration of the importance of having the whole question passed upon by Congress. Such compensating works can only be constructed by the authority of Congress and at very considerable cost. It is not a matter which is in the hands of the Secretary of War. Permission to divert water which will at one and the same time nullify the effect of past appropriations and make necessary similar expenditures in the future, should be granted only with the express consent of the body in whose hands the making of such appropriations and the authorization of such works rest.

Furthermore, in most cases such compensating works could only be constructed with the joint consent of our neighbor Canada. The United States Government alone would be unable, even if it were willing to spend its own funds, to compensate for the damage done through the lowering of these levels unless Canada were willing to join in constructing the portion of such works which would necessarily stand upon Canadian soil.

The question therefore becomes not merely national but international, and this leads me to the consideration of the arguments which were urged by both sides in reference to the treaty with Great Britain in respect to Canada of January 11, 1909. A careful consideration of that treaty fails to indicate to me that it is in any way controlling upon the questions now before me. It gives to the citizens of both countries certain mutual rights of navigation in the waters of the Great Lakes and their connecting rivers; but beyond that the question of the right to this diversion at Chicago seems to me to have been carefully excluded. The applicants for the permit have urged upon me that article 8 of the treaty gives a preference to the uses of water of the lakes for domestic and sanitary purposes over the uses of such water for navigation. Article 8, however, applies only to future cases brought before the International Joint Commission; and furthermore I am clearly of the opinion that the domestic and sanitary purposes referred to in that article were intended to be the "ordinary" uses of such waters for domestic and sanitary purposes referred to in Article 3. It would be quite contrary to our own national policy to give such a preference to an extraordinary sanitary use of such a character as to create a substantial injury to navigation. The matter has been before our own Supreme Court in the case of the *United States* v. *the Rio Grande Dam & Irrigation Co.* (174 U. S., 690). In that case the Supreme Court held that a company which proposed to take the water of the Rio Grande River for the purpose, among others, "of supplying water to cities and towns for domestic and municipal purposes" could be prevented from so doing when the result would be a substantial injury to the navigability of the Rio Grande River farther down. In its opinion the court said:

> The question always is one of fact, whether such appropriation substantially interferes with the navigable capacity within the limits where navigation is a recognized fact. In the course of the argument this suggestion was made, and it seems to us not unworthy of note, as illustrating this thought. The Hudson River runs within the limits of the State of New York. It is a navigable stream and a part of the navigable waters of the United States, so far at least as from Albany southward. One of the streams which flows into it and contributes to the volume of its waters is the Croton River, a non-navigable stream. Its waters

are taken by the State of New York for domestic uses in the city of New York. Unquestionably the State of New York has a right to appropriate its waters, and the United States may not question such appropriation, unless thereby the navigability of the Hudson be disturbed. On the other hand, if the State of New York should, even at a place above the limits of navigability, by appropriation for any domestic purposes, diminish the volume of waters, which, flowing into the Hudson, make it a navigable stream, to such an extent as to destroy its navigability, undoubtedly the jurisdiction of the National Government would arise and its power to restrain such appropriation be unquestioned; and within the purview of this section (Act of September 19, 1890, ch. 907) it would become the right of the Attorney General to institute proceedings to restrain such appropriation.

The treaty, however, contains provisions in its Article 10 by which "any questions or matters of difference arising between the high contracting parties involving the rights, obligations or interests of the United States or of the Dominion of Canada, either in relation to each other or to their respective inhabitants, may be referred for decision" to an international joint commission established by the said treaty. The hearing before me brought forth the fact that the Government of Canada regards the proposal contained in this application as one which affects the material interests of that country. The establishment by formal treaty between the two countries of a tribunal with jurisdiction to decide just such questions seems to me to afford an additional reason against the assumption of jurisdiction to decide the question by an administrative officer of one of those countries.

In short, after a careful consideration of all the facts presented, I have reached the following conclusions:

FIRST. That the diversion of 10,000 cubic feet per second from Lake Michigan, as applied for in this petition, would substantially interfere with the navigable capacity of the navigable waters in the Great Lakes and their connecting rivers.

SECOND. That that being so, it would not be appropriate for me, without express congressional sanction, to permit such a diversion, however clearly demanded by the local interests of the sanitation of Chicago.

THIRD. That on the facts here presented no such case of local permanent necessity is made evident.

FOURTH. That the provisions of the Canadian treaty for a settlement by joint commission of "questions or matters of difference" between the United States and Canada offer a further reason why no administrative officer should authorize a further diversion of water, manifestly so injurious to Canada, against Canadian protest.

The prayer of the petition is therefore denied.

HENRY L. STIMSON,
Secretary of War.

(c) *Report of the Consulting Engineer and Attorney for the Sanitary District* (reprinted from pro., Board of Trustees, January 16, 1913, p. 45):

CHICAGO, January 15, 1913.

Hon. Thomas A. Smyth, President of the Board of Trustees of The Sanitary District of Chicago:

DEAR SIR: Pursuant to instructions, your Consulting Engineer was in Washington, D. C., December 30th and 31st, 1912, for the purpose of ascertaining the status of the issue respecting the diversion of additional water through the Drainage Canal of the Sanitary District.

After a lengthy interview with General W. H. Bixby, Chief Corps of Engineers, U. S. A., the following letter was addressed to the Secretary of War:

WASHINGTON, D. C., Dec. 30, 1912.

SIR: Respecting the application of the Sanitary District of Chicago, dated February 5, 1912, for a permit to take water from Lake Michigan by way of the Chicago River and the Calumet River to the amount of ten thousand (10,000) cubic feet per second, I respectfully ask you to entertain a request for the withdrawal of this application or to amend the same.

The Sanitary District of Chicago will be able to present its reasons in full for such request two weeks from date, or at your later convenience.

On behalf of the Sanitary District of Chicago,

Respectfully,
(Signed) LYMAN E. COOLEY,
Consulting Engineer.

Honorable Henry L. Stimson,
Secretary of War, Washington, D. C.

(Copy furnished to General W. H. Bixby, Chief of Engineers, United States Army.)

In the subsequent interview with the Secretary of War, I discussed with him in a general way the position of the Sanitary District in regard to this application.

It would not be proper to express the attitude of the Secretary, further than to say: He did not see his way clear to reopen the case or defer his action upon the record as now made. His findings would be held for a few days and meantime he would entertain citations on legal propositions.

Your Consulting Engineer begs to report further that he again called on General Bixby and later advised you by wire.

On the following day, December 31st, a copy of the statement of March 29, 1912, made to the Secretary of War on behalf of the City of Chicago, as printed in the hearings before the Senate Committee on Commerce, April 16, 1912, was left at the Secretary's office and a further interview was had with the Chief of Engineers. The brief of the Consulting Engineer together with a brief upon legal propositions by the Attorney of the District were printed as speedily as possible.

In the meantime the Honorable Martin B. Madden on January 6, 1913, interviewed the Secretary of War and the President of the United States in order to defer a decision until the additional matter could be presented. The subject matter was considered at the Cabinet meeting of January 7th, and further time was also asked by Secretaries Fisher and MacVeagh.

On January 9th your Attorney proceeded to Washington with printed copies of the briefs above referred to for the purpose of personally presenting the same to the Secretary of War and the Chief of Engineers. Upon reaching Washington January 10th, your Attorney was supplied with a printed copy of the decision of the Secretary of War, dated January 8, 1913.

Your Attorney immediately attempted to present the matters to the Secretary of War together with a letter from the Consulting Engineer to the Secretary, but the attorney was refused an audience and was informed by persons in authority that no further or additional arguments, data or briefs would be considered or would change the decision rendered.

The additional matter could not, therefore, be submitted and you were advised by wire accordingly.

On January 11th, your Consulting Engineer sent the following letter to the Secretary of War and enclosed a copy of the letter of January 8th, which the attorney could not, under the circumstances, deliver for consideration by the Secretary:

CHICAGO, January 11, 1913.

DEAR SIR: Mr. Edmund D. Adcock, Attorney for the Sanitary District has wired this office that your decision respecting the application for an additional flow of water through the drainage channel is already in print and will be given out on Monday, January 13.

Mr. Adcock left Chicago on Thursday, for the purpose of laying before you printed copies of my brief and an additional brief upon legal points. He advises us that he has not presented same in view of the fact that the matter is already disposed of.

I enclose you herewith a copy of the letter which I had written to you and which Mr. Adcock was to deliver to you. I wish you to know that I made every effort in my power to carry out your suggestions, and to thank you for distinguished personal consideration.

Very respectfully yours,
LYMAN E. COOLEY,
Consulting Engineer.

Hon. Henry L. Stimson,
Secretary of War, Washington, D. C.
(Enclosure)

CHICAGO, January 8, 1913.

DEAR SIR: Referring to my note and my interview of December 30, 1912, respecting the diversion of water at Chicago. You stated you would entertain further legal references, and suggested I could make excerpts respecting legal propositions from my brief, "The Diversion of the Waters of the Great Lakes by Way of the Sanitary and Ship Canal of Chicago."

This brief has since been put in type, and I send herewith printed copies.

FIRST. Your attention is invited to the following:

(A) Right of Diversion; Topic numbers 34 to 42 inclusive, particularly T. 41 and 42; also Topics 37 and 10 respecting the Illinois and Michigan Canal.

(B) Canada: Topics 53 to 57 inclusive, particularly T. 55 and 56.

(C) Effect immaterial: Topics 43 to 45 inclusive, particularly T. 43.

(D) Benefits exceed damages: Topics 46 to 50 inclusive, particularly T. 49 and 50.

(E) Remedies: Topics 51 and 52.

(F) The Federal Permit: Topic 8.

(G) The Organic Law: Topics 3, 12, 13, 14, 15 and 16.

SECOND: Your attention is also invited to Appendix No. 1, the same being my statement on behalf of the City of Chicago, filed March 30, 1912.

This is part of the original hearing upon the subject matter, and it presents an outline of the facts and issues elaborated in the foregoing brief. It may be, therefore, that you can take judicial cognizance of the entire brief, particularly as substantially all the matters therein are accessible in official documents, and here assembled for convenience.

I invite your attention to the definition of "judicial notice" in the Montello case.

THIRD. The Attorney and Counsel of the Sanitary District of Chicago are now preparing a summary of legal citations, which they will forward during the week. I have advised them that you would entertain such matters.

FOURTH. The Sanitary District officials are engaged in the preparation of additional material, which they consider important, but I am unable to fix a definite date for its completion. Two exhibits accompany the brief. Two other exhibits are in preparation, which together with further appendices will be included in the brief as finally printed.

I trust, Mr. Secretary, that your decision may be deferred until you can review the matter herein enclosed, and that you may further find it consistent with your responsibilities to postpone such decision until the present Board of Trustees can lay before you all matters germane to the pending issues.

On behalf of the Sanitary District of Chicago.

Thanking you for your distinguished personal consideration, I am,

Respectfully,
LYMAN E. COOLEY,
Consulting Engineer.

Hon. Henry L. Stimson,
Secretary of War, Washington, D. C.

(Copy furnished to General W. H. Bixby, Chief of Engineers, United States Army.)

The following letter has been received together with a copy of the decision. The decision is hereto attached as "Exhibit A" (printed above), and the letter is as follows:

WASHINGTON, D. C., Jan. 10, 1913.

SIR: By direction of the Secretary of War, I inclose herewith a copy of his decision in the matter of the application of the trustees of the Sanitary District of Chicago for permission to divert from Lake Michigan 10,000 cubic feet of water per second.

Very truly yours,

(Signed) W. R. PEDIGO.
Private Secretary.

Mr. L. E. Cooley,
Chicago, Ill.

Inclosure: Copy of decision referred to.

It appears from the foregoing that the Secretary of War based his decision solely upon the application of February 5, 1912, and upon the hearings of February 28 and March 27, 1912, and has not entertained the request to withdraw or amend the application nor the additional brief and information.

Respectfully yours,

LYMAN E. COOLEY,
Consulting Engineer.
EDMUND D. ADCOCK,
Attorney.

(d) *The Chicago River Permit.* (Reprinted from Appendix "D" of the Report of the International Waterways Commission on the Chicago Drainage Canal, 1907, pages 36-9):

[Permit of July 3, 1896.]

IMPROVEMENT OF CHICAGO RIVER.

JULY 3, 1896.

SIR: I have the honor to acknowledge the receipt of your letter of 16th ultimo, requesting permission to make certain changes in the capacity of the channel of the Chicago River for drainage purposes at points indicated on the map accompanying the application, and in reply beg to say that upon investigation it is found that the permission requested can be granted upon the following conditions:

1. That while the general plan is approved, the sanitary district of Chicago must furnish plans in triplicate on an enlarged scale showing each proposed new bridge, each by-pass and

each new dock or wharf proposed to be built, in order that the Secretary of War may act intelligently in each case.

2. That this authority shall not be interpreted as approval of the plans of the sanitary district of Chicago to introduce a current into Chicago River. This latter proposition must hereafter be submitted for consideration.

3. That it will not cover obstructions to navigation by reason of this work while in progress or when completed.

4. That the United States shall not be put to expense by reason of this work.

5. That this authority will expire by limitation in two years from date unless extended.

Very respectfully,

Joseph B. Doe,

Acting Secretary of War.

B. A. Eckhart, Esq.,

President the Sanitary District of Chicago, Rialto Building, Chicago, Ill.

[Permit of May 8, 1899.]

Whereas by Section 10 of an act of Congress approved March 3, 1899, entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," it is provided that it shall not be lawful to alter or modify the course, location, condition or capacity of the channel of any navigable water of the United States unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same;

And whereas the sanitary district of Chicago, a municipal corporation organized under the laws of the State of Illinois, has constructed an artificial channel from Robey street, Chicago, to Lockport, and has heretofore been granted permission by the Secretary of War to make certain improvements in the Chicago River for the purpose of correcting and regulating the cross section of the river so as to secure a flowage capacity of 300,000 cubic feet per minute with a velocity of 1¼ miles an hour, it being intended to connect the said artificial channel with the west fork of the South Branch of Chicago River at Robey street in the said city of Chicago;

And whereas the said sanitary district of Chicago has now applied to the Secretary of War for permission to divert the waters of the said Chicago River and cause them to flow into the said artificial channel at Robey street, as aforesaid;

And whereas the said sanitary district of Chicago represents that such movable dams and sluice gates as are necessary to at all times secure absolute and complete control of the volume and velocity of flow through the Chicago River have been constructed;

Now, therefore, the Chief of Engineers having consented thereto, this is to certify that the Secretary of War hereby gives permission to the said sanitary district of Chicago to open the channel constructed and cause the waters of Chicago River to flow into the same, subject to the following conditions:

1. That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the sanitary district of Chicago to Congress for consideration and final action, and that this permit shall be subject to such action as may be taken by Congress.

2. That if, at any time, it become apparent that the current created by such drainage works in the South and Main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its South Branch.

3. That the sanitary district of Chicago must assume all responsibility for damages to property and navigation interests by reason of the introduction of a current in Chicago River.

Witness my hand this 8th day of May, 1899.

[SEAL.] R. A. ALGER,
Secretary of War.

JOHN M. WILSON,
Brigadier General, Chief of Engineers, U. S. Army.

[Permit of April 9, 1901.]

Whereas, under date of May 8, 1899, the Secretary of War granted permission unto the sanitary district of Chicago to open the artificial channel from Robey street, Chicago, to Lockport, and cause the waters of Chicago River to flow into the same, upon the following conditions, inter alia:

"2. That if, at any time, it become apparent that the current created by such drainage works in the South and Main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its South Branch;"

And whereas it is alleged by various commercial and navigation interests that the present discharge from the river into the drainage canal sometimes exceeds 300,000 cubic feet per minute, causing a velocity of nearly three miles per hour, which greatly endangers navigation in the present condition of the river;

Now, therefore, this is to certify that the Secretary of War, upon the recommendation of the Chief of Engineers, hereby directs said sanitary district to regulate the discharge from the river into the drainage canal so that the maximum flow through the Chicago River and its South Branch shall not exceed 200,000 cubic feet per minute.

Witness my hand this 9th day of April, 1901.

[SEAL.]

ELIHU ROOT,
Secretary of War.

[Permit of July 23, 1901.]

THE SANITARY DISTRICT OF CHICAGO,
SECURITY BUILDING,
CHICAGO, *July* 15, 1901.

SIR: I have the honor to request, on behalf of the sanitary district of Chicago, that your order of April 9, 1901, restricting the flow of water through the Chicago River to 200,000 cubic feet of water per minute, may be so amended as to permit the controlling works at Lockport, the outlet of the main drainage channel, to be so regulated as to permit at that point a flow of 300,000 cubic feet of water per minute between the hours of 4 P. M. and 12 o'clock midnight.

The board of trustees of the sanitary district have rigidly observed the restrictions of your order of April 9, 1901, but the result has been that the water in the main drainage channel has become greatly polluted and very offensive both to sight and smell and is working such hardship upon the valley communities as to evoke frequent protests from various cities and municipalities along the Desplaines and Illinois valleys.

By such a modification of your restricting order as is herein petitioned, it would be possible for the sanitary district to secure much better drainage of the city of Chicago and the purification of the waters of the Chicago River without any hardship or inconvenience whatever to the interests of navigation, as the opening of the controlling works to a flow of 300,000 cubic feet of water per minute would produce no appreciable effect upon the current of the Chicago River until three hours thereafter and would not produce the full effect until about eight hours after the opening of the gates. Therefore, by again diminishing the flow at midnight to the requirements of your order, or to 200,000 cubic feet of water per minute, the normal condition in the Chicago River would be restored before 6 A. M. on the following day, and thus no hardship or inconvenience occasioned to the navigation interests of the Chicago River.

I have the honor to be, very respectfully, yours,

ALEX J. JONES, *President.*

To the Hon. ELIHU ROOT,
Secretary of War, Washington, D. C.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
July 22, 1901.

Respectfully returned to the Secretary of War.

By an instrument dated April 9, 1901, the Secretary of War directed the sanitary district of Chicago to regulate the discharge from the Chicago River into the drainage canal so that the maximum flow through the Chicago River and its South Branch shall not exceed 200,000 feet per minute.

The sanitary district now asks that this order be so amended as to permit an increase of the flow into the canal to 300,000 cubic feet per minute between 4 P. M. and 12 midnight, daily.

It is the opinion of Major Willard, expressed in the accompanying letter of the 16th instant, that the request should be granted, subject to revocation by the Secretary of War in case the increase be found dangerous to navigation.

I concur in this opinion and recommend that the order of April 9, 1901, be modified accordingly.

G. L. GILLESPIE,
Brigadier-General, Chief of Engineers, U. S. Army.

[Third indorsement.]

War Department,
July 23, 1901.

Approved as recommended by the Chief of Engineers.
E. Root, *Secretary of War.*

[Permit of December 5, 1901.]

Whereas under date of May 8, 1899, the Secretary of War granted permission unto the sanitary district of Chicago to open the artificial channel from Robey street, Chicago, to Lockport, and cause the waters of Chicago River to flow into the same, upon the following condition, inter alia:

"2. That if at any time it becomes apparent that the current created by such drainage work in the South and Main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its South Branch."

And whereas the Secretary of War subsequently directed said sanitary district of Chicago to regulate the discharge of water into the Chicago Drainage Canal so that the maximum flow through the Chicago River shall not exceed 200,000 cubic feet per minute from midnight to 4 p. m., nor 300,000 cubic feet per minute from 4 p. m. to midnight.

And whereas said sanitary district of Chicago has applied to the Secretary of War for permission to increase the flow between midnight and 4 p. m. daily to 250,000 cubic feet per minute, and the Chief of Engineers has recommended that the increase applied for be granted, but that the rate of flow from 4 p. m. to midnight be reduced to 250,000 cubic feet per minute, so that the flow through the Chicago River shall not exceed 250,000 cubic feet per minute throughout the twenty-four hours of the day:

Now, therefore, this is to certify that, in accordance with the recommendation of the Chief of Engineers, the Secretary of War hereby gives unto said sanitary district of Chicago permission to regulate said discharge so that the maximum flow through the Chicago River shall not exceed 250,000 cubic feet per minute throughout the twenty-four hours of the day, upon the following conditions:

1. That this permission shall be in lieu of the present authorized rates of flow as stated above.

2. That the permission herein given shall be subject to such modification as in the opinion of the Secretary of War the public interests may from time to time require.

3. That said sanitary district of Chicago shall be responsible for all damages inflicted upon navigation interests by reason of the increase in flow herein authorized.

Witness my hand this 5th day of December, 1901.

Wm. Cary Sanger,
Assistant Secretary of War.

[Permit of January 17, 1903.]

Whereas under date of December 5, 1901, by an instrument supplementary to the original permission granted by the Secretary of War May 8, 1899, to the sanitary district of Chicago to open the artificial channel from Robey street, Chicago, to Lockport, and cause the waters of Chicago River to flow into the same, the Secretary of War, pursuant to authority reserved in said permission of May 8, 1899, gave permission to the sanitary district of Chicago to regulate said discharge so that the maximum flow through the Chicago River shall not exceed 250,000 cubic feet per minute throughout the twenty-four hours of the day, upon the following condition, inter alia:

"That the permission herein given shall be subject to such modification as in the opinion of the Secretary of War the public interests may from time to time require."

And whereas the said sanitary district of Chicago has applied for permission to increase the flow through the Chicago River from 250,000 cubic feet per minute to 350,000 cubic feet per minute during the closed season of navigation, in order to carry off the accumulations of sewage deposit which line the shores along said city:

Now, therefore, this is to certify that, in accordance with the recommendation of the Chief of Engineers, the Secretary of War hereby gives unto said sanitary district of Chicago permission to increase the flow through the Chicago River from 250,000 cubic feet per minute to 350,000 cubic feet per minute until the 31st day of March, 1903, after which date it shall be reduced to 250,000 cubic feet per minute, as now authorized, upon the following conditions:

1. That the permission hereby given shall be subject to such modifications as in the opinion of the Secretary of War the public interests may from time to time require.

2. That said sanitary district of Chicago shall be responsible for all damages inflicted upon navigation interests by reason of the increase in flow herein authorized.

Witness my hand this 17th day of January, 1903.

[SEAL.] WM. CARY SANGER,
Assistant Secretary of War.